Cruise Report

CC-115

Scientific Activities Undertaken - SSV *Corwith Cramer*

Lisbon, Portugal - Funchal, Madeira - Port Royal,
Antigua - Charlotte Amalie, St. Thomas

November 29, 1990 to January 7, 1991

Sea Education Association - Woods Hole, Massachusetts

DECEMBER

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		27	28	29	30	1
2 ALL GATHER 'ROUND THE MAIN MAST BOOT YULETIDE LOG FOR CHESTNUTS AND CANOLIS	3	4 LAND HO	5 ← Madeira	6 →	7 The tree the tree tree...	8 SALVAGE ... which would we got; LEGA; Jude?; John
9 SUMP	10 Line chaser Tropical! fruit swizzle; GAS KILLS FIVE; and Passed westward going through the Canaries	11	12 Fire in Galley! No-Aft Cabin! Tropic of Cancer 23° 26.5'N See ya! HAPPY HANAKKAH	13	14 Son, Take that boat south to 20°N latitude + bang a right for St Thomas; SUMP OVERFLOWS, DROWNS THREE	15 Playoffs UPDATE: Division Leaders Playoff AFC 1900 NFC 16:30 ... Student Busby gets ... in his ...
16 Terrorist Seltzer Bomb exploded in Galley ... SWIZZLE on the 1/4 deck; tropical drinks, yummy snacks, FUN	17 YOUR LEG HERE; FIDO	18 4 students die of Exaustion But no one notices...	19 ELEANOR 23	20 the BIG ONE! LIKE FINE CHEESE OR A SIDE OF BEEF EVERYTHING IMPROVES WITH AGE. OLD AGE KILLS ONE.	21 TIM CHANGES HIS SHIRT THANK GOD!	22 EAT PAPA, EAT! YOU CAN'T DISAPPOINT THE CHILDREN" NOBODY LIKES A SKINNY SANTA!!! BUZZBY LOOSES YET ANOTHER BUCKET!!!
23 THE TREMENDOUS	24 TRUFFLING	25 TRIPLETS TRIUMPH!!	26 Ah well, broke again	27 Oh Dear Oh Dear Will it Always Be Gray No Sun Again Today	28 To Be or Not To Be Is it relevant? This is the true question	29 "It's awfully tough to stop The horse when it starts smelling the baahn" J.W. in response when asked if we would be slowing for science. WELCOME
30	31 Assistant Steward Killed in Tragic Galley accident; So Long CC-115, we're going to miss you!!	1st YES! Just got my 7th hour of sleep since getting here!	2ND Depart Antigua	3RD Can you spell...? Superbowl Thursday Stay Tuned for Playoff Info	4	5

Table of Contents

Preface

This cruise report outlines the scientific research and academic program conducted on board SSV *Corwith Cramer* during late fall of 1990. The full ship's complement for this cruise is presented in Table 1.

C-115 was captained by John C. Wigglesworth. John proved to be an able and hard-working skipper. He was particularly supportive of our oceanographic mission and provided frequent and reasonable council throughout the cruise. In many ways we worked well together.

John was assisted by mates Rex McKeever, Dave Bank and Sean Bercaw. Rex was a real veteran of SEA cruises and his quiet confidence and skills were in evidence throughout our trip. I particularly appreciated his thoughtful and gentle approach to teaching and student advising. Our second mate, Dave, brought the character and style of the traditional mate to role on this trip. A handy seaman and skilled boat handler, he also provided a robust sense of humor and appreciation of the absurd. Sean served as bosun throughout our trip and kept *Corwith Cramer* in fine condition throughout.

Our engineer, Dan Lehman, was also an old hand to *Corwith Cramer* and served well in this regard. Our steward, Rick Jones, worked hard through all manner of weather extremes to keep the galley running and everyone well-fed. We are all particularly thankful for his efforts during this trip.

I am especially happy to acknowledge the efforts of the scientific staff on this trip. Tim Kenna, Ed Lyman and Heidi Lovett performed excellently while dealing with some difficult supervisory, equipment and planning situations.

I believe all members of the crew worked especially hard during this cruise, bringing enthusiasm to both their teaching and working tasks. The students of C-115 certainly benefitted from such an accomplished and pleasant crew. As Chief Scientist, I thank all involved for a most interesting and educational experience.

Table I. Ship's Complement for SSV *Corwith Cramer* Cruise C-115

Nautical Staff	
John Wigglesworth	Captain
Rex McKeever	First Mate
Dave Bank	Second Mate
Sean Bercaw	Third Mate
Dan Lehman	Engineer
Rick Jones	Steward
Scientific Staff	
R. Jude Wilber	Chief Scientist
Tim Kenna	First Scientist
Ed Lyman	Second Scientist
Heidi Lovett	Third Scientist
Students	
Peter Auerbach	Swarthmore College
Joan Brazier	Connecticut College
Heather Burt	Wesleyan University
Craig Busby	Colgate University
Hillary Cochrane	Cornell University
David Coler	Franklin and Marshall College
Carin Cutler	University of Michigan
Kim Gallagher	SUNY - College of New York
Julia Gutreuter	Cornell University
Terry Henry	University of the Virgin Islands
Liesl Hotaling	Fairleigh Dickinson University
Bill Kaericher	Kenyon College
Eleanor Kinney	Yale University
Beth MacDonald	Cornell University
Marko Melendy	Unity College
Rebeka Rand	Southeastern Massachusetts University
Allison Scheier	Mount Holyoke College
Jocelyn Stamat	Harvard/Radcliffe University
Kristin Stone	University of New Hampshire

Table 2 - Noon and Midnight Positions, SSV *Corwith Cramer*, Cruise CC-115

Date	Time	Log (nm)	Latitude (°N)	Longitude (°W)
11-28/90	1200	0	Alongside, Lisbon, Portugal	
11-29/90	0000	45	38.04	10.14
11-29/90	1200	135	37.43	11.66
11-30/90	0000	198	36.80	12.73
11-30/90	1200	223	36.68	13.60
12-01/90	0000	243	36.61	13.81
12-01/90	1200	296	36.16	15.37
12-02/90	0000	362	35.70	16.61
12-02/90	1200	396	35.34	17.26
12-03/90	0000	438	34.74	17.26
12-03/90	1200	474	34.21	17.31
12-04/90	0000	533	33.23	16.89
12-04/90	1200		Alongside, Funchal, Madeira	
12-05/90	0000		Alongside, Funchal, Madeira	
12-05/90	1200		Alongside, Funchal, Madeira	
12-06/90	0000		Alongside, Funchal, Madeira	
12-06/90	1200		Alongside, Funchal, Madeira	
12-07/90	0000	609	32.18	16.69
12-07/90	1200	664	31.23	16.28
12-08/90	0000	718	30.45	16.03
12-08/90	1200	767	30.15	15.82
12-09/90	0000	811	29.99	15.85
12-09/90	1200	869	29.18	16.36
12-10/90	0000	920	28.70	17.27
12-10/90	1200	991	27.58	17.73
12-11/90	0000	1056	26.78	18.20
12-11/90	1200	1120	25.63	18.93
12-12/90	0000	1190	24.53	19.29
12-12/90	1200	1253	23.50	20.08
12-13/90	0000	1301	22.66	20.59
12-13/90	1200	1355	22.01	21.25
12-14/90	0000	1422	21.05	22.03
12-14/90	1200	1485	20.28	23.03
12-15/90	0000	1558	19.90	23.98
12-15/90	1200	1621	20.00	25.07
12-16/90	0000	1672	19.81	26.24
12-16/90	1200	1742	19.39	27.58
12-17/90	0000	1804	18.93	28.48
12-17/90	1200	1864	18.62	29.07
12-18/90	0000	1927	18.10	30.82
12-18/90	1200	1999	17.64	32.19
12-19/90	0000	2064	17.47	33.19

12-19/90	1200	2130	16.94	34.10
12-20/90	0000	2193	17.16	35.41
12-20/90	1200	2260	17.60	36.48
12-21/90	0000	2325	17.57	37.82
12-21/90	1200	2400	16.91	39.33
12-22/90	0000	2471	16.63	40.55
12-22/90	1200	2535	16.20	41.73
12-23/90	0000	2597	16.05	42.73
12-23/90	1200	2652	16.06	43.81
12-24/90	0000	2750	16.09	45.94
12-24/90	1200	2821	16.11	47.17
12-25/90	0000	2890	15.79	48.47
12-25/90	1200	2968	15.14	48.82
12-26/90	0000	3002	15.18	50.28
12-26/90	1200	3086	15.77	51.58
12-27/90	0000	3168	16.12	53.22
12-27/90	1200	3256	15.62	55.02
12-28/90	0000	3345	16.04	56.63
12-28/90	1200	3433	16.54	58.27
12-29/90	0000	3522	16.82	60.01
12-29/90	1200		Alongside, Nelson's D'Yard, Antigua	
12-30/90	0000		Alongside, Nelson's D'Yard, Antigua	
12-30/90	1200		Alongside, Nelson's D'Yard, Antigua	
12-31/90	0000		Alongside, Nelson's D'Yard, Antigua	
12-31/90	1200		Alongside, Nelson's D'Yard, Antigua	
01-01/91	0000		Alongside, Nelson's D'Yard, Antigua	
01-01/91	1200		Alongside, Nelson's D'Yard, Antigua	
01-02/91	0000		Alongside, Nelson's D'Tard, Antigua	
01-02/91	1200	3641	17.13	61.21
01-03/91	0000	3722	17.31	63.28
01-03/91	1200	3759	17.30	63.37
01-04/91	0000	3790	17.27	63.48
01-04/91	1200		At Anchor, Virgin Gorda	
01-05/91	0000		At Anchor, Virgin Gorda	
01-05/91	1200		Drake Sound	
01-06/91	0000		At Anchor, Coral Bay, St. John's	
01-06/91	1200		At Anchor, Coral Bay, St. John's	
01-07/91	0000		At Anchor, Coral Bay, St. John's	
01-07/91	1200		Alongside, Charlotte Amalie, St. T.	

Academic and Research Program

A 24-hour science watch was maintained throughout the six week period of SSV *Corwith Cramer* cruise CC-115. These watches consisted of teams of three students and one or two members of the scientific staff. Students were instructed in the use of sampling gear and scientific procedure encompassing many aspects of physical, geological, chemical, and biological oceanography. Instruction was provided while performing work for project research. Students were sufficiently familiar with scientific procedures after four weeks to largely assume responsibility for operations during the last weeks of the cruise.

Formal instruction was provided on a daily basis through lectures given by the scientific staff. Lecture topics were designed to cover aspects of oceanography appropriate for the cruise track and research projects and not readily acquired from practical experience. A list of topics covered at sea is included below.

Oceanographic studies undertaken during this cruise were developed during the six weeks prior to the cruise through directed literature research and seminars. The goal was to "take advantage" of the intrinsically interesting oceanographic opportunities offered by the cruise track. A mix of projects which were outlined on shore were taken to sea to be developed as time and the environment allowed. Every oceanographic station was made for the purpose of actual research; no sample was taken solely for the purpose of demonstration. In this way, students were given the opportunity to learn by participation in the actual research activities. A list of project work undertaken during this cruise is found in Table 2.

CC-115 was comprised of two three-week courses in oceanography. The on-board experience was preceded by a six-week course in oceanography on shore. Successful completion of the entire SEA Semester program (seventeen academic credits) includes eleven credit-hours in oceanography. Letter grades for each of the two shipboard courses were determined via staff evaluation of on-watch performance, project research and examinations.

◆ Introduction/ Cruise Plan	(Wilber)
◆ Ocean Acoustic Tomography	(Wilber)
◆ Climate Change and Sea Level Cycles I	(Wilber)
◆ Climate Change and Sea Level Cycles II	(Wilber)
◆ The Art and Science of Crustacean ID	(Kenna)
◆ Life at Deep-Sea Vents	(Wilber)
◆ Introduced Species in Marine Environments	(Wilber
◆ Geology of Madeira (Field Trip)	(Wilber)
◆ Carbonate Banks, Atolls and Platforms	(Wilber)
◆ Research Results: Saba Bank	(Wilber)
◆ Oceanography from Space I	(Wilber)
◆ Oceanography from Space II	(Wilber)
◆ Those Nasty Ole Hagfish	(Lyman)
◆ Classification and Biology of Sea Turtles	(Lovett)
◆ Low Pressure Storms at Sea	(Wigglesworth)

Table 3 - Oceanographic Research Projects Undertaken During CC-115

Project	*Data Analysis*
The Bathymetry and Seismic Facies of the Salvage Island Platforms	David Coler Bill Kaericher Kristin Stone (Jude Wilber)
Sedimentary Processes and Sedimentary Facies of the Salvage Island Platforms.	Craig Busby Terry Henry Jocelyn Stamat (Tim Kenna)
Air-Sea Interactions over the Eastern North Atlantic.	Peter Aurbach Heather Burt Ali Scheirer (Heidi Lovett)
A High Resolution Study of Eastern North Atlantic Hydrostratigraphy with Emphasis on the Madeira Mode Water.	Liesl Hotaling Marko Melendy Karin Cutler (Lovett)
A CTD Study of the Eastern North Atlantic Hydrostratigraphy with Emphasis on the Mediterranean Water.	Beth MacDonald Julia Gutreuter Hillary Cochrane John Burt (Kenna)
An Investigation of the Core Properties and Fine Structure of Mediterranean Water in the Eastern North Atlantic Ocean.	Rebeka Rand Eleanor Kinney Kim Gallagher (Lyman)
Surface Salinity Trends on a Trans-Atlantic Section with Emphasis on the Formation of Salinity Maximum Water.	Craig Busby Beth MacDonald Hillary Cochrane (Kenna)

An Investigation of Neuston Organisms on a trans-Atlantic Section during Early Winter with Emphasis on *Halobates* Distribution.	Marko Melendy Ali Scheirer Carin Cutler Liesl Hotaling David Coler Rebeka Rand Kristin Stone (Lyman, Kenna)
An Investigation of Tar and Plastic in the Neuston Layer on a trans-Atlantic Section.	Eleanor Kinney Bill Kaericher Virginia Land (Lyman)
A CTD Investigation of the Subsurface Salinity Maximum Water on a trans-Atlantic Section.	Virginia Land Peter Aurbach Heather Burt (Lyman)
An Investigation of the Bathymetry, Seismic Facies and Sediment of Saba Bank.	EVERYONE !!

The research program of CC-115 was designed to permit collection of physical, chemical, biological and geological data from several distinct oceanographic areas of the Eastern North Atlantic. The cruise track (Fig. 1; Table 3) offered the rare opportunity to sample from the mouth of the Mediterranean Sea, through the Canary Current and Meddies, and on a long section across the entire central Atlantic. Our research efforts ended in the Caribbean Sea with an extensive team project on Saba bank. It was, on first consideration, a vary monotonous trip but our research results revealed a surprising degree of intricacy along and below this cruise track.

Our research program was centered around topics investigated during the shore component. These topics offered both the possibility for original observations and measurements within the scope of the *Cramer's* capabilities and potentially significant results. Data and ideas were shared between projects through formal and informal project discussions. Project research was addressed on a team basis consisting of three students and a scientific advisor, an approach which was experimental for SEA Semester. I believe the students and staff of CC-115 did an exceptional job in embracing this method and I believe the educational and scientific results of this cruise provide a strong testimony to this fact.

Cruise Narrative

Lisbon to Madeira

CC-115 began late in the day of Tuesday, November 27th when we pulled away from our berth in Lisbon's inner harbor (and most of the Soviet fishing fleet) and entered the flood of the Tagus River Estuary. After taking on fuel we anchored for dinner and a good night's sleep. The following day dawned sunny and calm and, after completing orientation and drills, we headed out to sea on a bearing which would become oh-so-familiar to us on this trip - 270°. Before us lay the North Atlantic Ocean at its greatest breadth. Our leave-taking of Portugal was calm but the next 6 days were not. CC-115 got a taste of the stormy winter Atlantic within 24 hours. A pair of LOs conspired to place *Cramer* in a highly undesirable position - that of fighting a head wind in a very confused sea. No sooner had operations begun when most were suspended as *mal de mar* and the seas took their toll. Three days out *Cramer* suffered minor damage during a fire in the mainmast boot. The rapid response of our engineer, Dan Lehman, prevented further damage. The cause of the fire was linked to the overheating of a couple of the hardwood wedges which held the mast in position - at least one of these was clearly turned to charcoal.

In the aftermath of this, deck boxes began to break loose and things started falling from the rigging. We decided to seek shelter and re-assess our plans. Our first scheduled port stop was to be in the Canaries but we headed for Madeira of necessity. Here we found a snug harbor and a beautiful, intriguing island. During our stay, city of Funchal installed one of the most high-wattage Christmas light I have ever seen - a project which apparently kept the public workforce busy most of December! In addition to our time in the capital city two field trips over and around the island were completed in a study of the local geology and other interesting stuff.

Captain John Wigglesworth located the local weather station and kept a very close eye on the storms in the area. A 'window of opportunity' opened for us on the 6th of December and *Cramer* left Madeira under clear, calm skies. In terms of our scientific efforts the cruise really began this night.

The Salvage Islands

First on our agenda was the desolate and mysterious Salvage Islands. Although historically well-known we could find essentially no scientific information on these intriguing "rocks". Dave Coler, Bill Kaericher (Und Frans, Und Hans) combined with Kristin Stone in working exceptionally hard on the bathymetry and seismic facies of the platforms. For this project we collected ~ 200 line-km of 3.5 khz seismic data over a period of two days. These data resulted in two interpretations of the bathymetry of this area. Figure 2 shows the "two platforms with saddle" view while Figure 3 shows the "three peaks" interpretation. Figure 4 is a profile view derived from Figure 3 along the line A-A'. The entire vessel worked very well in collecting the data (Figs. 6-8) used in this project which was a particularly challenging combination of sailing and science for our initial oceanographic work on this cruise. The figures presented here are the first detailed bathymetric charts produced for this area.

Examining the modern benthic environment of the platforms also proved to be a challenging endeavor. For this project the trio of Steve Busby, Terry Henry, and Jocelyn Stamat in close consultation with Tim (Lab Man) Kenna were pressed into service. Our sampling sites are shown in Figure 5. The five samples acquired during a hairy ride close to the rocks covered the range from bank-top to middle slope - an almost ideal spread for the survey work we attempted. Results of the sedimentological analysis are shown in Figures 9 and 10. A summary of the facies transition identified along the southern margin of Salvegem Grande platform is shown in Figure 11. The findings of this project were most unexpected. The data revealed a carbonate-dominated bank top - this at a latitude of 30° N and under the direct influence of a "cold" geostrophic current (Canary Current). To be sure, the type of carbonate-producing organisms we found were different from those known to dominate western North Atlantic systems but one familiar player - red algae, in the form of rhodoliths - was found to dominate the bank-top facies. To the south, two other sedimentary facies, both dominated by carbonate sediment were identified on the slope. Although the seismic data did not show any significant build-up of slope sediment it was clear from our findings that the Salvage Islands platforms have gone through at least one phase of "over-production" and "export" of carbonate sediment during the post-Wisconsin sea level rise. Amazingly, this information these platforms in the same class as other "shedder" carbonate platforms known from the western North Atlantic and Caribbean (Fig. 12).

Air-Sea Interactions

Despite getting our butts kicked during the first week, *Cramer* did continue to collect basic data on air-sea interactions. Ultimately this effort produced one of the most illustrative data sets on our trip. We called on Peter Aurbach, Heather Burt and Ali Scheirer, under the able direction of Professor Ed Lyman to draw out the importance of this information. Their findings are presented in Figures 13-17. Figure 13 shows a map of our daily positions during the first three weeks of the trip. This period covered most of our latitudinal drop from the mid-30s to our old friend, 16° N' latitude. Air temperature data for this period was plotted against both log reading and cruise hour. Clear patterns on at least three different time/space scales emerged from this work (Fig. 14). The first of these is the "Big Picture" trend of T_a increasing with decreasing latitude as we approached the tropics (Fig. 14A). A number of well-defined "mesoscale" data trends (sharp rises, flats, drops) are observed when T_a is plotted vs. cruise hour (Fig. 14B). These trends are closely correlated to mesoscale atmospheric events - specifically the movement of Lo pressure storms over the eastern Atlantic and their cyclonic circulation patterns. Finally, as lower latitudes were reached, the T_a data are dominated by a strong diel cycle with peaks in the late morning/early afternoon and lows in the late afternoon and early evening.

Similar (and related!) data were also acquired on sea surface temperature (T_s). Figure 15 A shows the Big Picture trend of increasing T_s with decreasing latitude - a linear trend with almost exactly the same slope as the T_a data trend. T_s data is not as readily affected by mesoscale atmospheric disturbances. Rather, mesoscale effects are typically found in the presence of oceanic "storms" such as eddies. Although Mediterranean Water Eddies (Meddies) were encountered during our trip these are primarily mid-water features and did not affect the surface data. The only mesoscale feature identified in the T_s data was the presence of the Azores Front encountered early in our first week.

All the data from Madeira on is characterized by a strong diel cycle (Fig. 15B). This cycle is less regular than that found for T_a. At times this cycle was "in phase" with the T_a cycle

(Fig. 15C) but often gave the impression of a "climbing sine wave" moving through the T_s data (Fig. 15B). Because of the constant motion of the *Cramer* we were unable to isolate either the temporal or spatial variables to further investigate this idea. Based on the combined data set we hypothesized that the T_s cycle we observed was related to and probably driven by the T_A cycle. The unevenness in the diel signal of surface temperature may well be related to lag times associated with feedback mechanisms operating between the two systems.

Trends in barometric pressure (P_B) were examined in conjunction with wind patterns (Fig. 16). An expected Big Picture trend in P_b is all but obscured in our data by the mesoscale effects related to LO pressure storms. In particular, the LOs of December 1st and December 9th are well represented. The pressure "rebound" from this second storm (and subsequent linear decline for the remainder of the data) is the only vestige of the expected High-to-low latitudinal trend. This group of data are best described as a "fuzzy envelop" of values which, when expended, shows very well-developed diurnal cycles. (Fib. 16B). For much of this leg the P_B data are characterized by "10 o'clock highs" and 5 o'clock lows". These cycles are the results of atmospheric tidal effects which are commonly best developed in tropical areas - free from the mesoscale disruption of the mid-latitude mixing energy.

Some of our most graphic data is found in Figure 17. Here, P_B is plotted against Beaufort Force (F_B). A strong linear trend is found with an R^2 of .92. These data clearly show the relationship between mesoscale LO pressure stroms and mixing energy in the eastern Atlantic.

Hydrostratigraphy of the Eastern Atlantic

Once we had weathered the storms and Madeira and were truly underway, CC-115 began a regular program of MBTs and CTDs. The goal of this work was the investigation of the hydrostratigraphy (water layers) of the eastern North Atlantic on, a number of different spatial scales. Because of the rapid transit of *Cramer* through the area, we assumed that all data were essentially time-equivalent. Clearly such an assumption would not work for the surface ocean and atmospheric data but was generally applicable for our water column work.

From the data collected, three projects were addressed. The first of these took the form of the "300 m Temperature Section". For this, CC-115 turned to Liesl Hotaling, Marko Melendy and Karin Cutler under the direction of Heidi Lovett. This group worked exceptionally hard and diligently in compiling the section shown in Figure 18. One of the most difficult tasks of this project was assessing the quality of the data. In using an old MBT we had the advantage of reliability and durability but some serious problems in precision were encountered. Thus the identification and elimination of "artifacts" from the data proved trying. The results were well worth it.

Figure 18 presents a very rare view of two "pools" of Madeira Mode Water (MMW) - the eastern Atlantic equivalent of the more voluminous and well-known 18° Water of the Sargasso Sea. In the early part of the section (MBTs 1&2) we found a 17° thermostad extending from the surface to nearly 100 m. This is clearly the 1990-1991 MMW in the making - just starting its intrusion to the south and west of the area of formation (which *Cramer* just "grazed" in our initial westward surge, Figure 19). Between BT 6 and 26 a 17° thermostad, ~100 m thick, is found below the surface pool of light, tropical water. This is most likely the 1989-90 MMW.

Sinking of this water the previous year, in combination with southerly and westerly transport by the regional flow regime has extended the 17° water from above 35° N to at least 20° N.

Where the 300 m section aimed for a high-resolution picture of temperature, the "2000 m Hydrographic Sections" project was aimed at a lower-resolution picture of the entire upper and middle water column. One of the primary objectives of this work was the investigation of the Mediterranean Water in the Eastern Atlantic and the search for the ever-elusive Meddies. In this effort Beth MacDonald, Julia Gutreutter, Hillary Cochrane and John Burt (with Tim Kenna) addressed an extremely large data set. Sixteen CTDs acquired in the Canary Current and Mediterranean Eddy field were analyzed to produce a 2000 m section for temperature, salinity, and density. The data were contoured by hand (A parts in Figures 20-22) and electronically processed using SURFER software (B parts in Fig 20-22).

The temperature sections revealed a highly-stratified water column with the degree of stratification increasing toward the tropics. The primary large-scale structure observed is the "10°C" thermostad found near 1200 m in the early part of the section. This layer severely disrupts the "normal" temperature structure of the region and pinches out in a southerly direction. Waves in the 9° and 10° isotherms suggest higher-order structures present in the layer but resolution of these by temperature alone is poor. The salinity section (Fig. 19) presents some of the most interesting data collected on our trip. Here, the 10° thermostad layer is clearly defined as a salinity-maximum layer centered at 1200 m. In addition, it seems that the high-salinity layer is not uniform but rather consists of a series of discrete, regional, high-salinity zones.

These sections show the influence of Mediterranean Overflow Water (MOW) on the regional hydrostratigraphy. In much the same way that MMW sinks to its equilibrium density level and becomes entrained to the south, MOW also sinks but to a much deeper depth. The volume of MOW is at least an order of magnitude greater than that of MMW but its intrusion is more latitudinally limited. Rather than the well-developed lens seen for MMW, the MOW breaks up to the south and is entirely absent by CTD-10. The break-up MOW results in discrete pools of relatively "pure" MOW known as Meddies separated by zones of relatively diluted (lower salinity) MOW. Finally, it can be seen from the density section that, despite major variability in both the temperature and salinity sections, the 'compensating effect' of these two results in a well-stratified water column with isopycnal surfaces gently sloping opposite to both the T and S isolines.

From the CTD data emerged a project devoted (and I do mean *devoted*) to examination of the "core" characteristics of the MOW. For this work, Drs. Rand, Kinney and Gallagher were pressed into service under the wise tutelage of Ed Lyman. Using highly expanded CTD views of the core zone of the MOW (Figs. 23-24), these investigators uncovered a number of extremely interesting relationships. First, the temperature and salinity anomaly associated with the MOW is strongest and "simplest" in the core of MOW found closest to the Straits of Gibraltar. Second, a number of sections were relatively unaffected by the MOW. Third, and most intriguing, was the degree of fine structure found in the core areas of "distal" MOW.

The fine structure is revealed in both the T-Z and S-Z profiles (Figs. 23A, 24A) but is most graphically apparent on the T-S plot shown in Figure 24B. Here, it is clearly seen that microlayers of relatively pure MOW interdigitate with the surrounding 'diluted' MOW. The signature of the pure MOW digits is seen on the T-S diagram as a series of 'left-hand' digits in the T-S data - these defined by rising temperature in conjunction with rising salinity. On some profiles as many as five microlayers are found within the core of the MOW. This "shuffling" of microlayers of water of different salinity and temperature (but equal density) is similar to the "thin layer dynamics" found along the edges of Warm Core (Gulf Stream) Eddies in contact with Shelf and Slope waters on the western side of the Atlantic.

Definition of the fine structure of the MOW was both an exacting and challenging project for all involved. In addition, this work has produced a unique data set for future work on the "far side" of the Atlantic.

Crossing That Big Ocean There...

By December 15th we had been to sea for nearly three weeks and had logged over 1500 nm. We had accomplished many of our scientific goals on the eastern side of the ocean but were still looking at 2000 nm before our first Antillean landfall. For the next two weeks *Cramer* turned with devotion to the business of moving west. Our sampling during this period was limited to Neuston Tows, Surface Stations and an occasional CTD. From these data, three projects were fashioned.

The first of these was focused on surface salinity trends as an indicator of our oceanographic neighborhood. This project was addressed by Craig Busby, Beth MacDonald, Hillary Cochrane and Tim Kenna. In this effort three different methods of determining surface salinity were employed and tested. The first of these was measurement of replicates of bucket samples using the salinometer (which Professor Kenna recalled from the grave at least twice during the crossing). These data are shown in Figure 25A. In general, the replicate samples from each station provided closely-matched data on salinity. The quality of our bottle data was assessed via statistical analysis which determined the"Δ" value or difference in S found between station replicates. These data are shown in Figure 25B. In general, replicate values fell within .01 -.1 ppt. Considering that replicates were always measured on entirely separate salinity runs (often days apart) this shows remarkable quality control on this analysis. Unusually high Δ values were encountered in some sample pairs and the decision to use either the A or B bottle was made in view of regional salinity trends (Fig. 25A).

The overall trend in surface salinity shows a latitudinally-related rise in S values between Lisbon and the Canary Islands. As a surface pool of salinity max water was encountered near the Canaries, we turned west. From here to the other side of the Atlantic two important findings were revealed. First, the salinity max pool of the central subtropical Atlantic is broken by relatively low- salinity water (low 36 ppt values) near the Mid -Atlantic Ridge (cruise hour 450 in Figure 25A). To the west of the ridge, the surface Sal Max returns, 0.1 to 0.2 ppt stronger than to the east of the ridge.

In much the same fashion that our investigation of the MMW demonstrated the compartmentalization of the North Atlantic by the ridge, the two part division of the surface Sal

Max is also apparently related to the ridge. Perhaps this break in the Sal Max is a function of the regional sea surface topography which, due to reduced gravity over the ridge, is elevated in mid-ocean. In addition to the bottle data, we determined surface salinity by taking extended surface readings with the CTD during deep casts. In general, the CTD surface readings were in close agreement with the bottle data (Fig. 26A). In an effort to increase the resolution of the surface salinity data set we attempted a program of "short" CTD casts using surface water in large pickle bucket. This technique had provided excellent results on a previous cruise (W-105) but we found very poor agreement between bucket casts and the other two methods of salinity determination (Fig. 26B). A bunch of bucket casts were attempted but, when the data were statistically assessed, this technique was abandoned - to the general delight of all involved.

The temperature data collected in conjunction with the salinity data provided additional insights on the controls of surface salinity. The T-S plot of surface values is shown in Figure 27 and reveals trends essentially identical to the S vs Cruise Hour plot (Fig. 25A). Here, the low-salinity break near the ridge is found in the 24-25° C range. The two Sal Max pools are seen to be centered around 23° C, for the eastern pool, and 26° C for the western pool.

When the early gradient in salinity is examined in conjunction with temperature, a rather surprising result is obtained. Fig 28A shows SS plotted vs density. Here it can be seen that, as salinity increases, density *decreases*. The reason for this is found in the relatively more important influence of temperature increasing along this same gradient. (Fig. 28B).

One of the more interesting crossing projects turned out to be our investigation of the subsurface Sal Max Water Mass (SMW), also known as Subtropical Underwater. In crossing at 16° N we had a perfect opportunity to examine E-W characteristics of this little-studied water mass. SEA has acquired the largest single data set on this water but almost all of it is from fall cruises along 60-65° W longitude. For analysis of the SMW, Virginia, Peter and Heather stepped in with Ed providing the moral support.

The essence of their work is shown in Figure 29. In this figure CTDs 10-24 between longitude 18°W and 51°W are shown and SMW is shaded. These profiles begin on the far eastern Atlantic where no Sal Max is found - only an irregular halostad between 50-250 m (CTD-10). From CTD-12 to CTD-22 the characteristics of the "eastern basin" SMW are revealed. This layer is generally a weak, largely asymmetric layer with a poorly developed Sal Max near 70 m. In this area there is some indication that the SMW "floats" on and interfingers with a quasi-isohaline layer just below - probably a vestige of the MMW. To the west to of the ridge it is very clear that "western basin" SMW floats on the quasi-isothermal and -isohaline remnant of the western Atlantic 18° Water. In these data the trend in surface salinity is also revealed as SS is generally high (near to or greater than 37 ppt) to the east of the ridge. The low salinity 'stripe' around the ridge is shown in CTD 23 and 24 where SS is at or below 36 ppt.

In addition to these findings we observed that both the definition and continuity of the SMW increases westward from the ridge. The value of the actual Sal Max of the layer increases significantly with longitude as seen in Figure 30A. In close association with this is a near-linear increase in the temperature at the depth of the Sal Max (Fig. 30B). These data are in agreement with our surface salinity findings in supporting a "two-pools" source for the Sal Max Water in the North Atlantic. On the eastern side of the ridge the surface pool gives rise to a subsurface SMW of relatively low salinity (36.6-36.8 ppt) and low temperature (23-25° C). To the west of the ridge the surface salinity pool gives rise to a high-salinity (37.1-37.3 ppt) and high-temperature (26-27.5 °C) mode for this same layer. *To our knowledge this is the first work to suggest "bimodal" origin for this water mass.*

Neuston Happenings

SEA's neuston projects have consistently produced excellent results particularly those focused on one of the long-term data sets in which SEA specializes. As with most other SEA data neuston findings are primarily from western NA cruises and from along latitudinal (N-S) gradients. CC-115 had the opportunity to investigate both a N-S gradient in the eastern North Atlantic and a long E-W gradient at the latitude of crossing - 16° N. The work of three research teams was employed in our neuston studies. Marko, Ali and Liesl (with Ed) and David, Becca and Kristin (with Tim) turned to the extensive task of analyzing the zooplankton and other critter data from the 25 replicate tows. Eleanor, Bill and Virginia (again with Ed) analyzed the surface distributions of our favorite pollutants - tar and plastic. These findings are summarized in Figures 31-33.

If there is one thing we learned on this crossing it was the wisdom of the expression "blue, blue, blue, dead, dead, dead". This is particularly apparent in the extremely low volume of organisms obtained in our tows - even when the net was towed at unusually high speeds or over distances greater than our standard of 1 nm. The big lesson derived from our steady sampling of the surface Atlantic during December was an appreciation of the true desert nature of the central ocean basins. In addition the "monotonous" quality of this huge ecosystem, as described by McGowan, was also readily apparent. Throughout our efforts, copepods (many clear, "counter-shaded", or a deep oceanic blue) dominated all the zooplankton (Figs. 31A, B). It made little difference in this regard if we were considering only day or only night tows. Other major constituents of the zooplankton were similarly monotonous and included euphausids, pterpods, cheatognaths and siphonophores.

Our data on *Halobates* proved substantially more interesting (Fig. 32). Here, we discovered winter *Halobates* above 30° N. Between 30-20° N *Halobates* numbers increased in a generally "patchy" distribution pattern. Our major finding in this category was that the number of *Halobates* increases substantially below 20° N latitude with a population dominated by juveniles. This is a data trend nearly identical to that determined by SEA for the western side of the ocean. Although it does not constitute "proof", these findings do support the working hypothesis that *Halobates* are capable of extensive latitudinal migrations to the North Equatorial Current for "spawning" purposes. Interestingly, *Halobates* were found in the complete absence of *Sargassum* - an association for which there is some data from the western side of the Atlantic.

Although SEA's data set on plastic and tar is the largest of its kind we know virtually nothing about the eastern North Atlantic or the North Equatorial Current. Based on data acquired from the WNA we hypothesized that the Eastern Atlantic was primarily a zone of "input" and "throughput" where no major concentrating mechanisms exist for the build-up of the long-lived surface pollutants. Our data (Fig. 33 A, B) provide some support for this hypothesis. The highest concentrations of both plastic and tar were found within the first 1200 miles of our trip (up to and near the Canary Islands). The distribution of both of these pollutants showed discrete peaks and a generally patchy distribution within this interval. The amount of plastic dropped dramatically to "0" and tar declined substantially after 1200 miles as we turned along our crossing route. The low neuston numbers for these pollutants were confirmed by visual observations of the surface waters.

Both tar and plastic were qualitatively assessed for age using a numeric scale related to degree of weathering. It was found that both tar and plastic from the Eastern Atlantic was "fresh", indicating a relatively short life in the neuton layer. These findings are in sharp contrast to the age characteristics of tar and plastic "populations" found in the central gyre of the Atlantic (Sargasso Sea). From these data we conclude that most of the tar and plastic between Lisbon and the Canaries is the result of local input via ships working the heavily traveled commercial lanes in this area. The paucity of tar and plastic in the North Equatorial Current is ascribed to the relatively "rapid transit" of tar and plastic westward in this flow field. In addition to these speculations we also observed that down-mixing energy for most of the crossing was relatively high and thus "t & p" may have been removed from the neuston layer as a result of Langmuir circulation and other down-welling processes.

By the 23rd of December we had been "long at sea" with nearly 1000 nm still lying before us. At this point, with exciting data on board, most of our sampling was suspended as *Cramer* stretched for Antigua. Between 1200 on the 23rd and our noon arrival in Antigua on the 29th we averaged over 125 miles per day ! By the time we came alongside in Port Royal, *Cramer* had run 3000 nm by the log - not including much of the Salvage Island work for which the log was hauled. From Madeira, we had come 2500 nm thereby completing the single longest leg of any SEA cruise! And most of it was done in what can only be described as a challenging sea. For most of our crossing, *Cramer*, already tail-heavy with water, carried short sail and rolled through an arc of nearly 50° with a beam sea running. This passage was a tribute to all who participated !

Our time in Port Royal spanned the last days of 1990 and the first of 1991. We found Port Royal unusually crowded with vessels for the holidays including a number of truly world-class yachts (as Jocelyn can well attest !). In addition to enjoying the traditional island diversions CC-115 set a new (veranda) standard for project presentations as all our data were presented and discussed under the palm trees of the old fort ....

Upon our departure from Antigua we turned our sights toward Saba Bank - a large and totally submerged carbonate platform to the west of volcanic Saba Island.

The Great Saba Bank Affair

Saba Bank has been the topic of long-term research by SEA vessels for a number of years. As a final effort of our trip a two-day program of sailing and science was formulated for Saba Bank and carried out entirely under the direction of the students of CC-115. The results of this work are seen in Figures 34 to 38. The ship's cruise track is shown in Figure 34. Along this route we collected 3.5 khz seismic data in combination with bottom samples from a variety of depths. Preliminary findings on this platform had suggested that it was of the general "shedder" variety - that is a carbonate platform which had both "overproduced" and "shed" carbonate sediment during the latest sea level rise. The shedding process is thought to be critical in the history and morphologic evolution of carbonate platforms over geologic time.

The results of the our work on Saba were summarized and presented to the ship's company by the chief scientist. Later, this work was expanded on by SEA staff scientists for a pair of professional presentations at a symposium on carbonate platform in the Caribbean (see abstracts in Appendix). The major findings of our work on Saba Bank reveal a highly asymmetric platform with a steep (precipitous) southern margin, a 'tilted' bank top and a long, extended northern profile (Fig. 36). This theme of 'asymmetry toward the north" set by bank morphology is echoed in a number of other bank characteristics. Sediment cover over most of the bank is thin and patchy with the southern 70% of the bank being essentially sediment-free (Fig. 37). Near the northern margin the thickest bank top deposits are found in an asymmetric bank-edge sand wedge. To the north and west of the bank edge, the slope is covered by a thick layer of muddy sediment down to a depth of 500 m. It is this blanket of sediment (and similar, older layers, Figure 36, which apparently control the asymmetric (snow-drift like) building of the platform in a northerly direction. Each layer is laid down during the shedding interval occurring during each of the many sea level changes which have marked the last 10 million years of earth history.

One of the more interesting aspects of the sediment data is the discovery of a "mud max" on the slope at ~ 200 m depth (Fig 38). Although the mud is clearly of bank-top origin its concentration so high on the slope is anomalous when compared to the sediment distributions found along other shedding platforms. Based on these data, in conjunction with the observation that Saba Bank is a platform whose shedding edge is dominated by a strong salinity max at ~200 m, we hypothesize that the pycnocline associated with the SMW has influenced the settling and distribution of mud. This presents fascinating possibilities for future research along the northern margin of Saba Bank.

And Who Can Forget...

The remainder of our journey was wind-down and wrap-up. We sailed north to the Virgins and played awhile with the *Westward,* who had completed her Canaries-Antilles Leg slightly ahead of us. We anchored and swizzled in the beautiful Coral Bay of St. Johns and it was here that many noteworthy things came to pass. Including, of course, the great *Blueberry Pie Eating Contest.* In this event bold teams were stripped to the waste (!) and their hands shackled behind. In the supplicant position each team was presented with a pie at the break in the deck of dear ole *Cramer.* The gun sounded and the snarfling was begun! When the juice had settled one thing was clear - the heavily favored team of Buzzby and Kenna had been bested by bigger fools. The Tremendous Truffling Triplet were honored as the official winners although a strong protest was lodged by Wigglesworth and Wilber who fought through their beards (and the mean taunts of the crowd) to consume their pie before all other contestant *pairs*. In general, a good time was had by all.

The morning of January 7th found us underway for St. Thomas. It was a bright day with a favorable breeze as we sailed downwind, under the island of St. T., and into Charlotte Amalie. As we sailed toward our berth on the Main Street we shortened sail until (without use of the engine, without even thinking about it Jones,) we came to rest gently alongside - just as the St. Thomas independence celebration - complete with bands and waving dignitaries - passed our lines. We cheerfully and modestly accepted the accolades of the assembled masses with gracious waves and smiles. I'm here to tell you kids it's *never* like this and, even if we had planned it, could not have been more perfect !

Many of the ships company stayed on for some R&R in the islands and, upon the arrival of *Westward,* the Second Annual Inter-Vessel Softball Game was played on Emile Griffith Field. Happily, I am able to report that *CC* whipped *WW* by some astronomical score which I believe was 30-something to just-something.

The entire experience of a trans-Atlantic cruise is a rare event for most people. To be able to retrace the route of the Great Explorer, Columbus, 500 years later *and* to sample in the wake of the first great Oceanographic Vessel, the *Challenger,* only 100 years removed in time is the rarest of trans-Atlantic adventures. The company of CC-115 is in proud company indeed following this voyage. In the final analysis our trip covered over 4000 nm - nearly double the distance of many SEA cruises. The quantity and, in particular, the quality of the scientific information acquired on this trip is truly impressive. These findings are a tribute to all involved in this cruise but most especially the students of CC-115. As Chief Scientist I thank all for a most enjoyable and educational experience.

R. Jude Wilber
Chief Scientist

CC-115 Figures

The following section contains most of the figures referred to in the text of this report. The following figure is found as a fold-out in the back envelope:

Figure 29

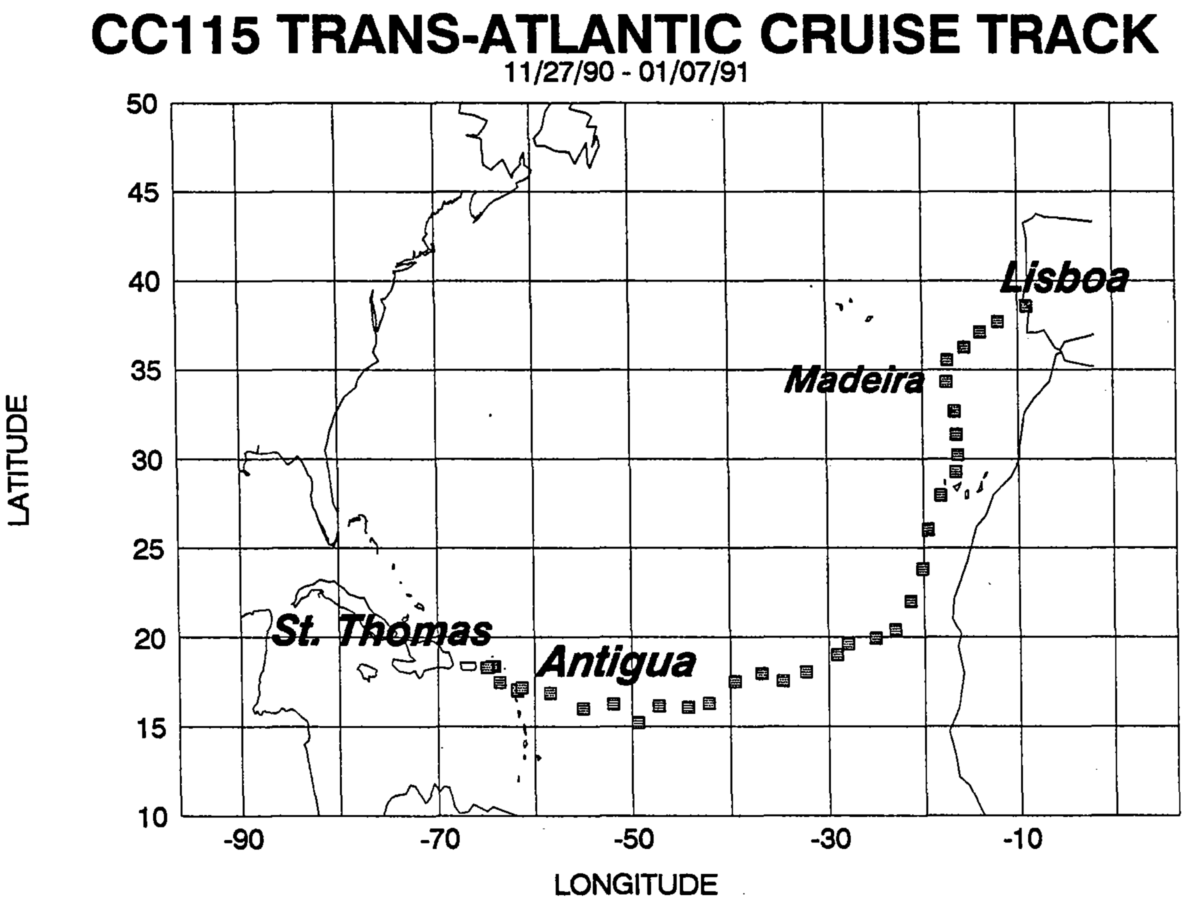

CC115 TRANS-ATLANTIC CRUISE TRACK
11/27/90 - 01/07/91
50
45
40
35
30
25
20
15
10
LATITUDE
-90
-70
-50
-30
-10
LONGITUDE
Lisboa
Madeira
St. Thomas
Antigua

Figure 1

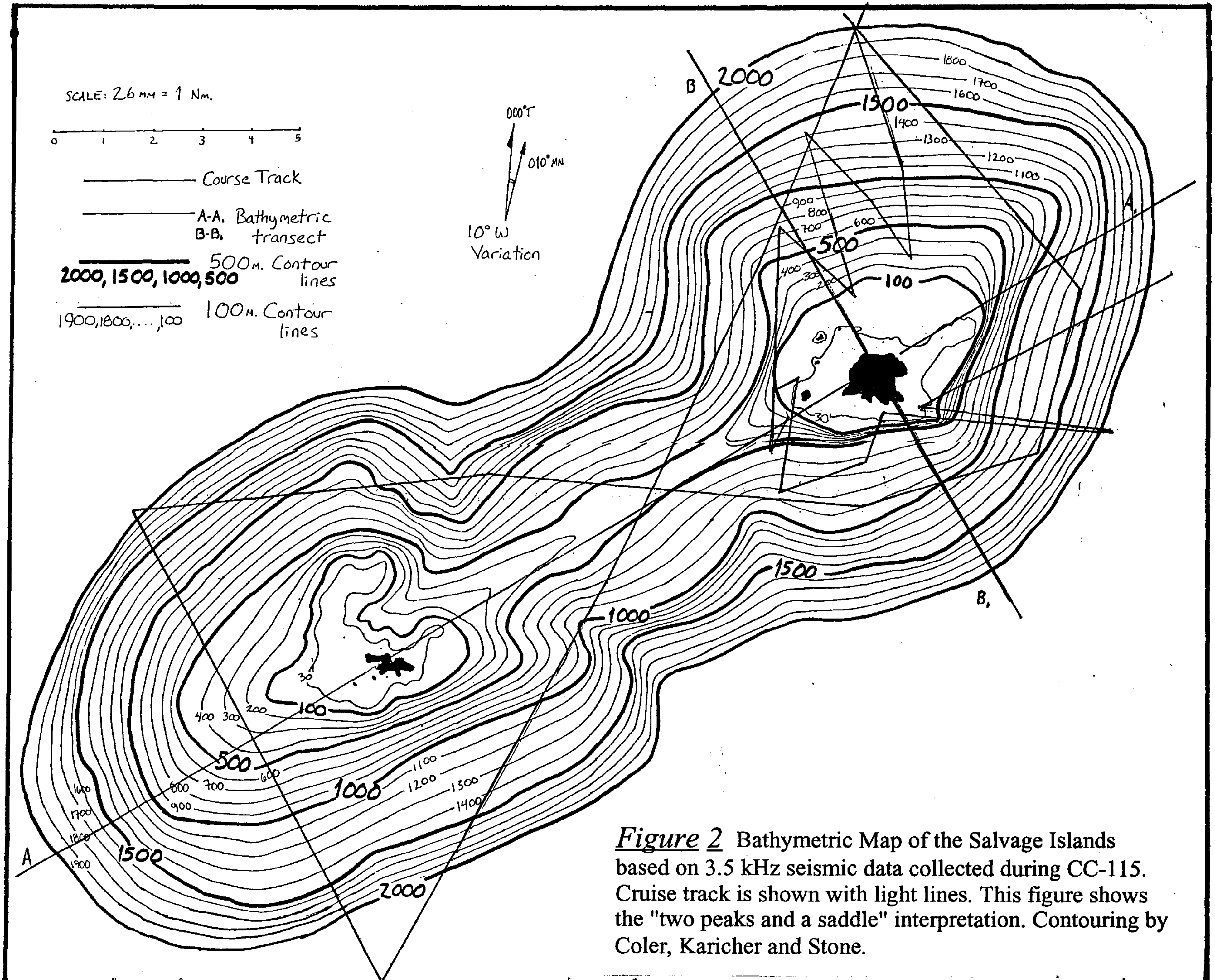


Figure 2 Bathymetric Map of the Salvage Islands based on 3.5 kHz seismic data collected during CC-115. Cruise track is shown with light lines. This figure shows the "two peaks and a saddle" interpretation. Contouring by Coler, Karicher and Stone.

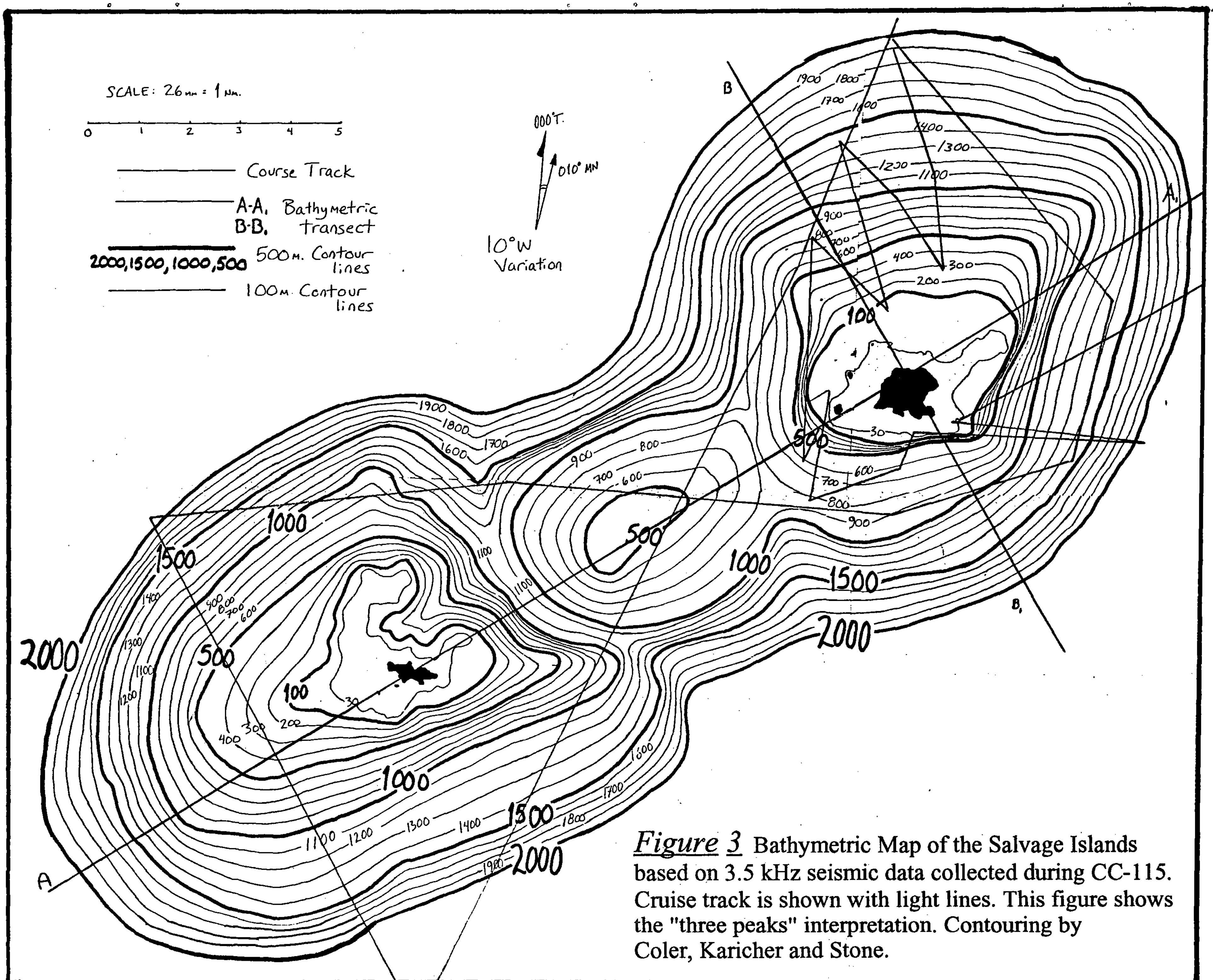


Figure 3 Bathymetric Map of the Salvage Islands based on 3.5 kHz seismic data collected during CC-115. Cruise track is shown with light lines. This figure shows the "three peaks" interpretation. Contouring by Coler, Karicher and Stone.

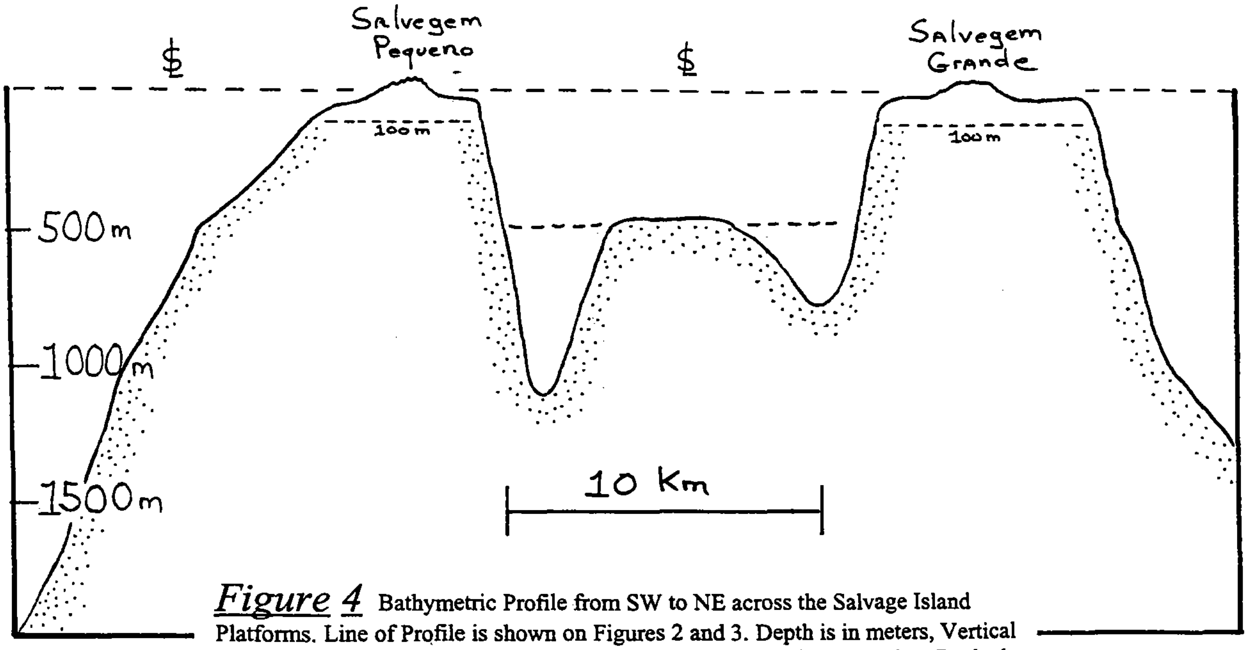
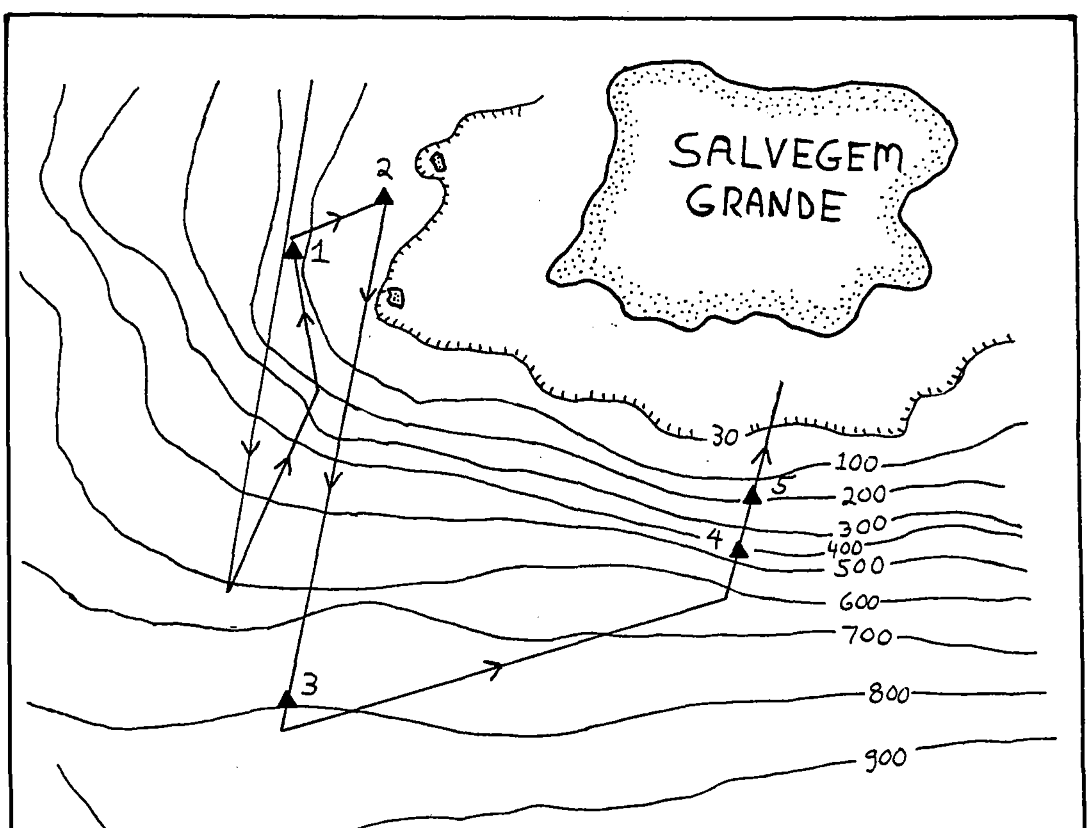


Figure 4 Bathymetric Profile from SW to NE across the Salvage Island Platforms. Line of Profile is shown on Figures 2 and 3. Depth is in meters, Vertical Exaggeration = 10X. Solid profile line shows "three peaks" interpretation. Dashed lines show alternative "two peaks and a saddle" view. Shelf break is at 30 meters. The islands of Salvegem Pequeno and Salvegem Grande occupy 10-30% of the platform area. Profile by Coler, Karicher and Stone.

Figure 5 Bathymetric Map in area of sediment sampling along the southern slope of Salvegem Grande. Figure shows cruise track in this area and location of the five samples obtained. Contours in meters. Map by Busby, Henry and Stamat.



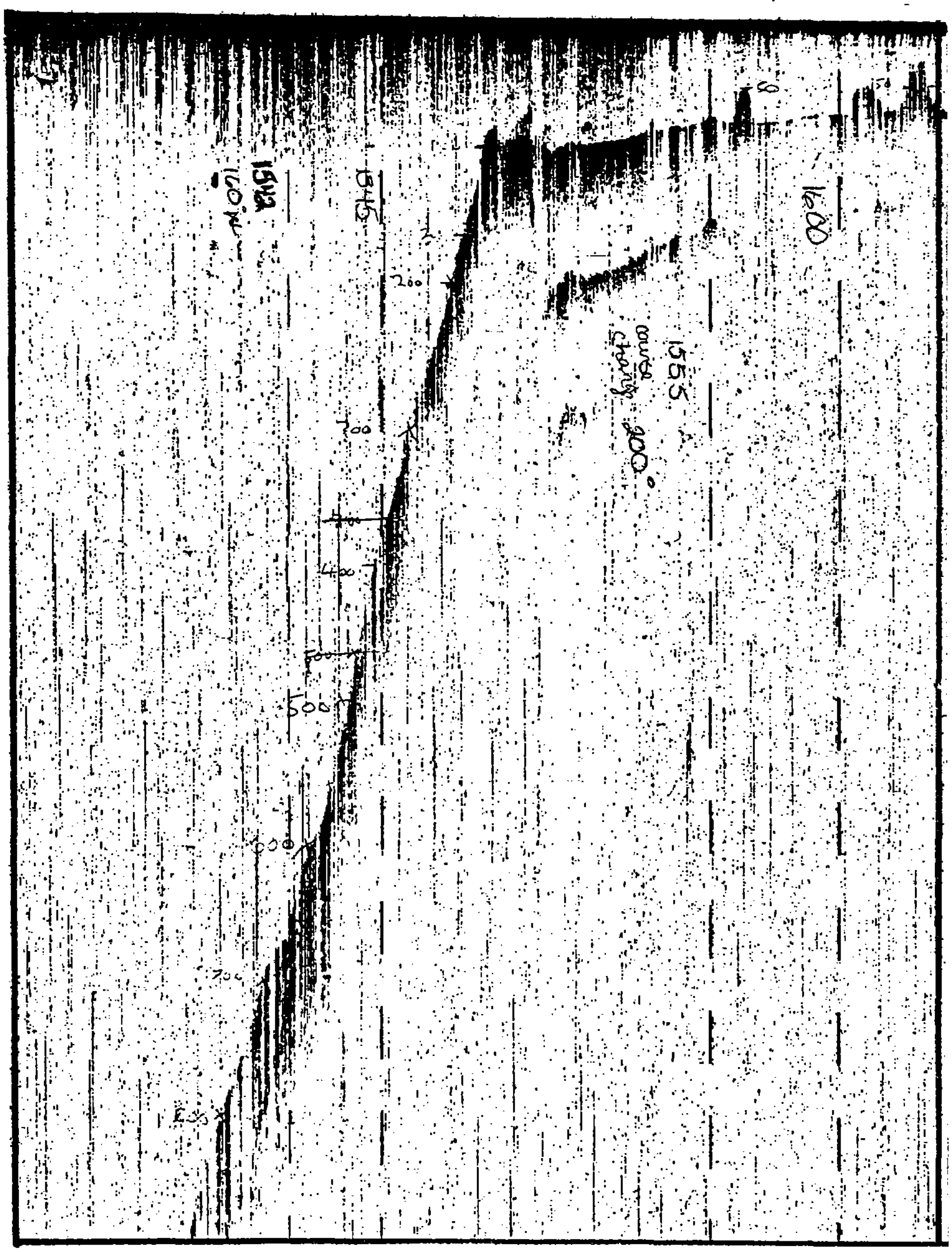


Figure 6 3.5 kHz seismic profile of northwestern bank edge of Salvegem Grande Platform. The steep slope is marked at the top by a bank-edge reef (?) and gently sloping carbonate ramp. Pinnacles on the bank top shoal to 35 m. The depth range shown is 0-900 meters, the lateral distance is 3-5 miles.

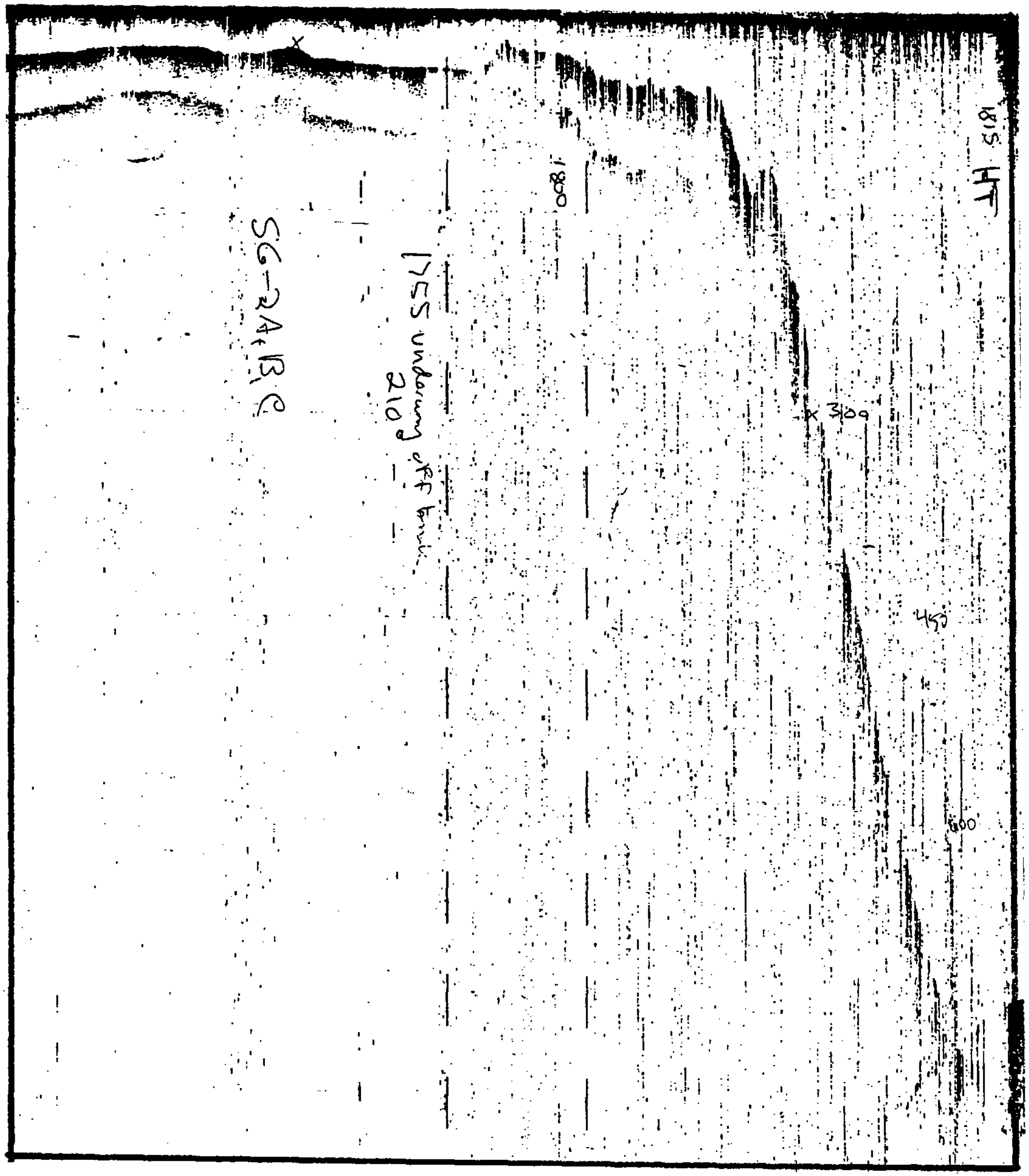


Figure 7 3.5 kHz seismic profile of the southern margin of Salvegem Grand Platform. Vessel was hove-to for first part (left side) of profile while platform surface was sampled. Additional samples were obtained down the adjacent slope. Depth range shown is 0-900 m, second half of profile covers a couple miles.

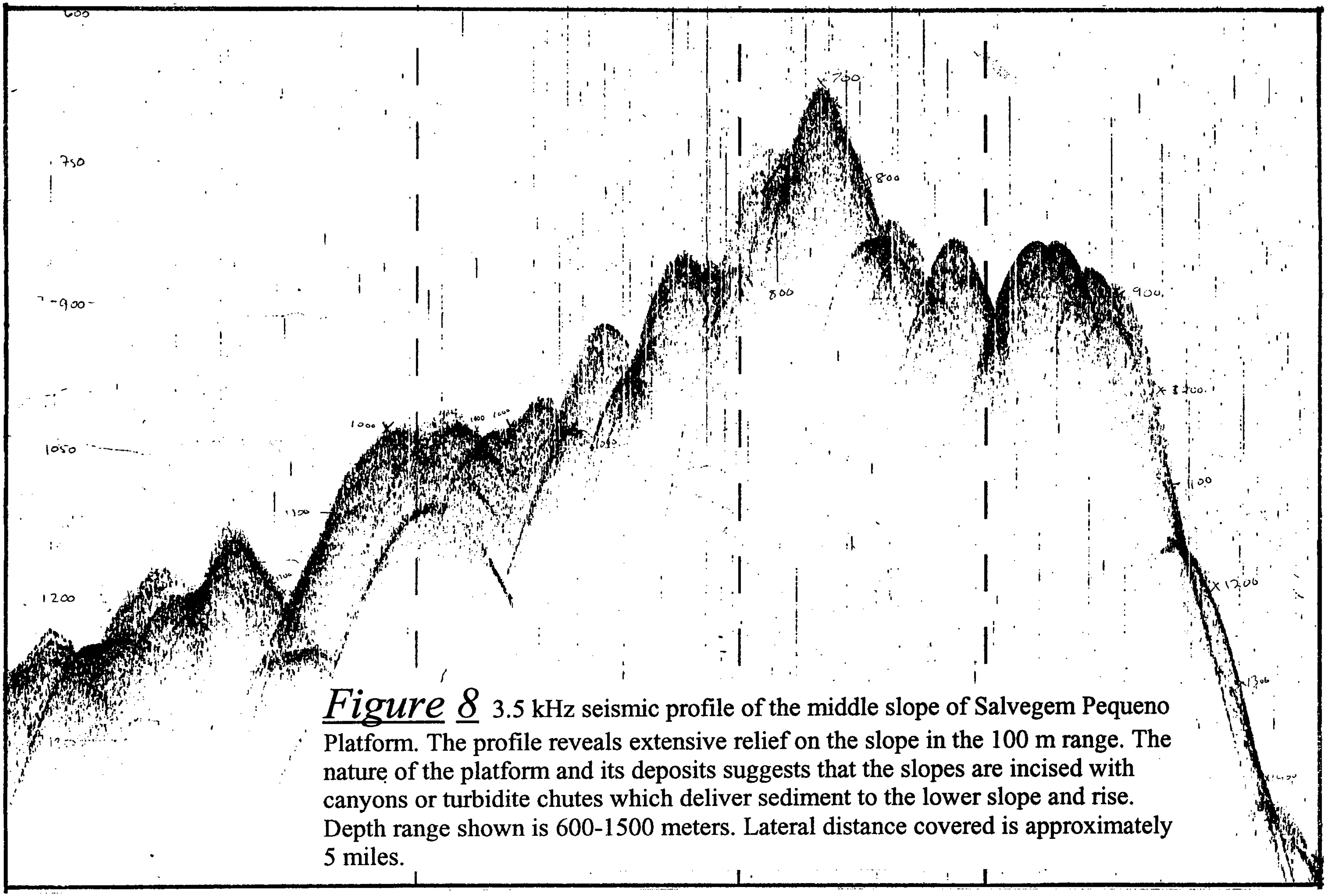
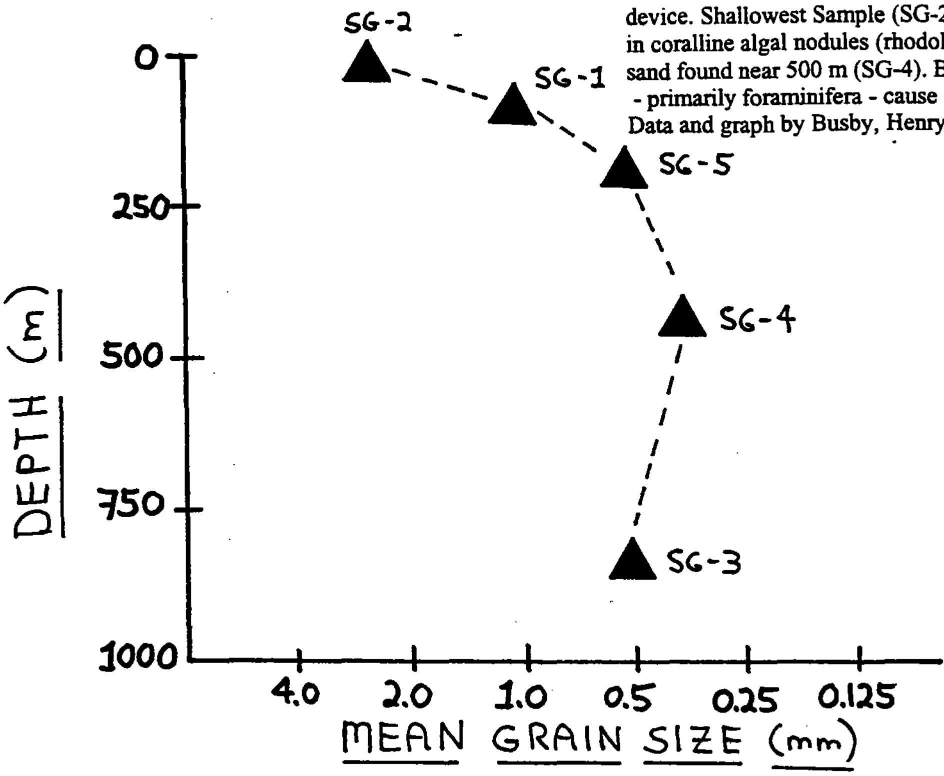


Figure 8 3.5 kHz seismic profile of the middle slope of Salvegem Pequeno Platform. The profile reveals extensive relief on the slope in the 100 m range. The nature of the platform and its deposits suggests that the slopes are incised with canyons or turbidite chutes which deliver sediment to the lower slope and rise. Depth range shown is 600-1500 meters. Lateral distance covered is approximately 5 miles.

Figure 9 Cross-plot of Depth of Sample vs. Mean Sediment Size for five samples from the southern slope of Salvegem Grande Platform. "SG" designation indicates Shipek Grab as sampling device. Shallowest Sample (SG-2) is a pebbly gravel deposit rich in coralline algal nodules (rhodoliths). Finest sediment is a medium sand found near 500 m (SG-4). Below this depth planktonic grains - primarily foraminifera - cause an increase in grain size with depth. Data and graph by Busby, Henry and Stamat.



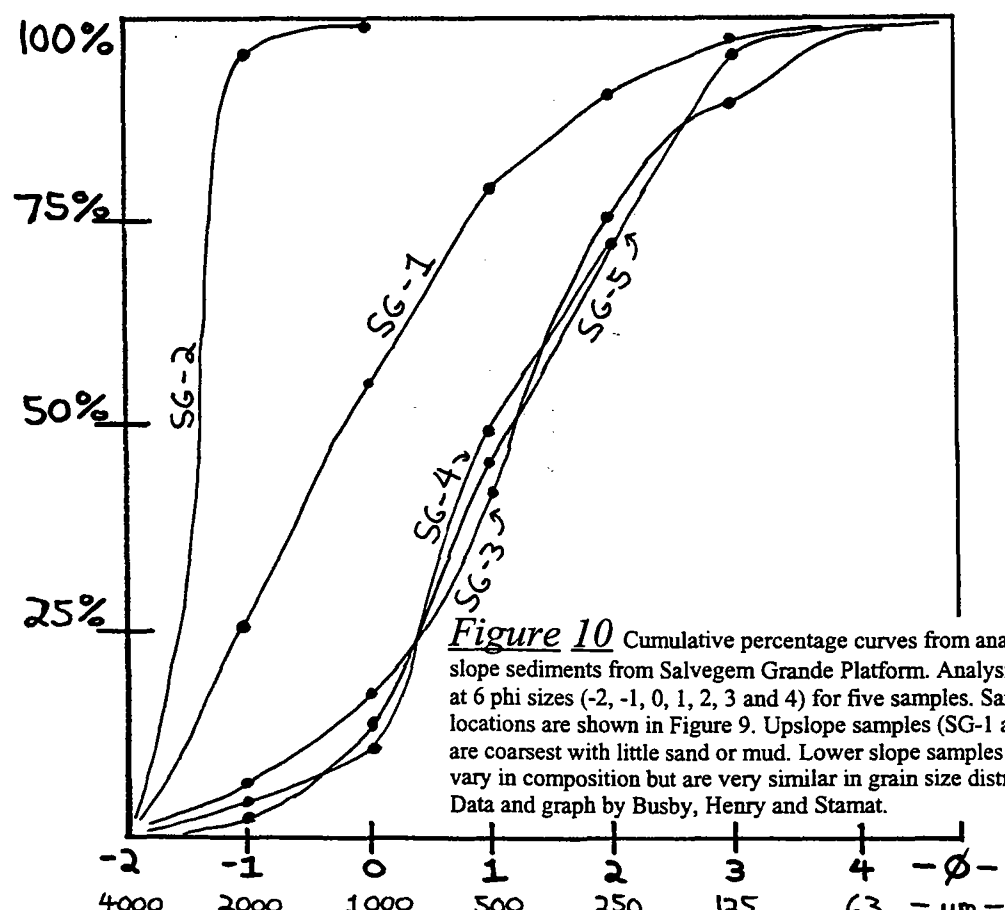


Figure 10 Cumulative percentage curves from analysis of slope sediments from Salvegem Grande Platform. Analysis completed at 6 phi sizes (-2, -1, 0, 1, 2, 3 and 4) for five samples. Samples locations are shown in Figure 9. Upslope samples (SG-1 and 2) are coarsest with little sand or mud. Lower slope samples (SG-3, 4, 5) vary in composition but are very similar in grain size distribution. Data and graph by Busby, Henry and Stamat.

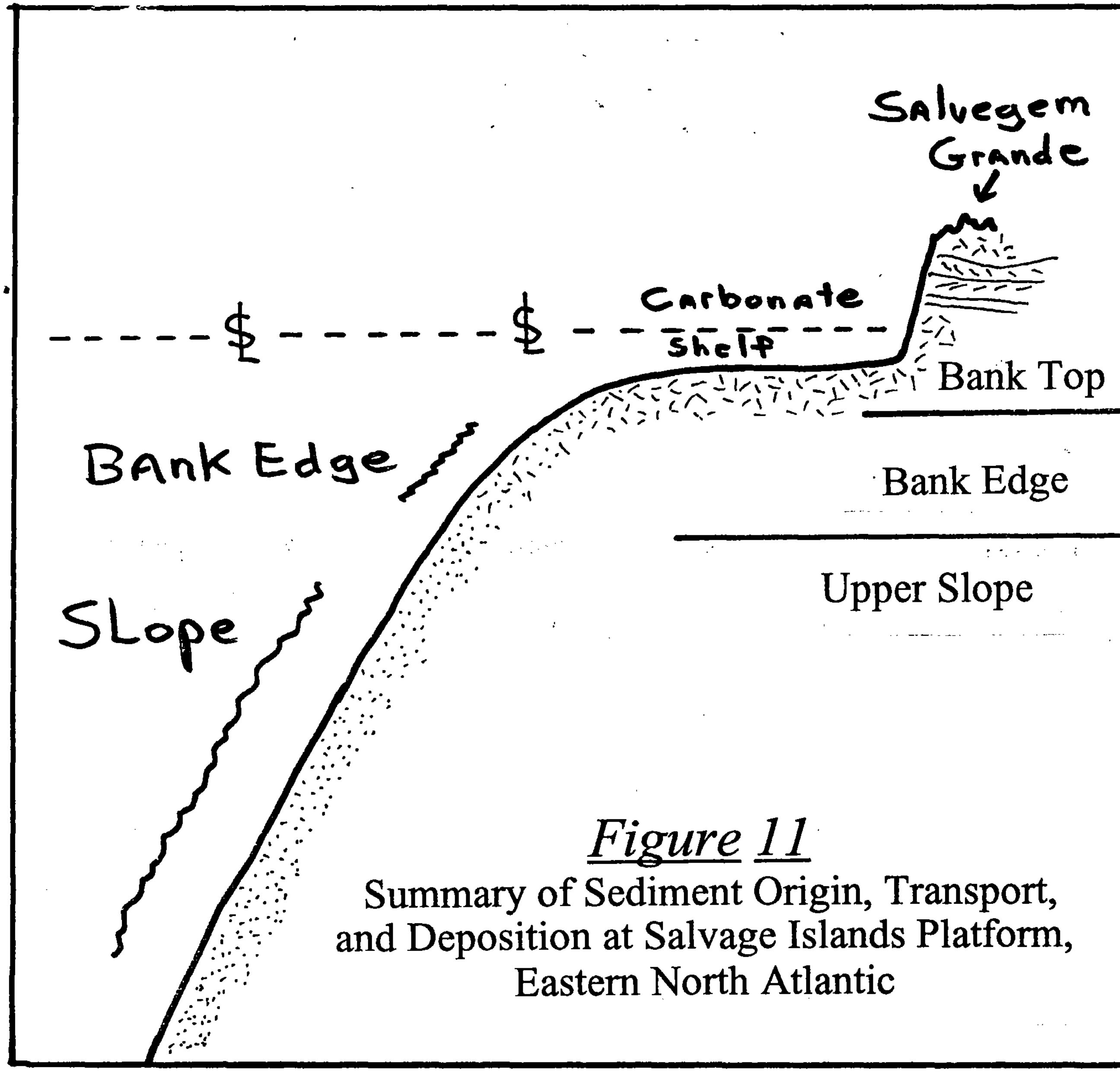


Figure 11

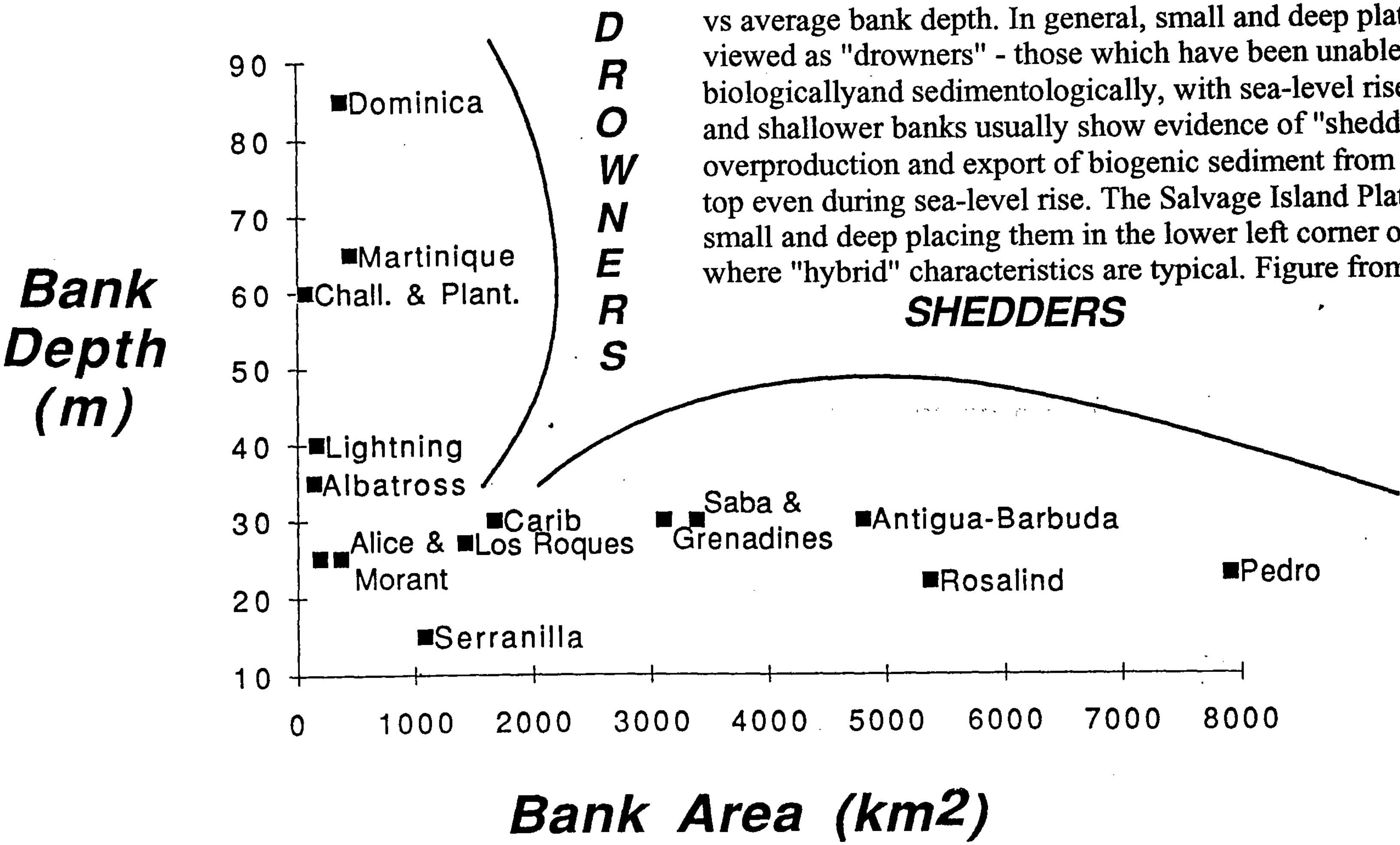
Summary of Sediment Origin, Transport, and Deposition at Salvage Islands Platform, Eastern North Atlantic

Bank Top	Salvegem Grande contributes terrigeno -clastic debris to the shelf. This includes sand and some basaltic cobbles. The submerged portion of the bank top is a carbonate shelf with a thin sediment cover of rhodoliths, worm tubes and bivalves. Sediment on the bank top is winnowed of fine sediments leaving a pebbly gravel out to the bank edge.
Bank Edge	The bank edge is a transitional zone which receives sediment from the shelf - primarily coarse carbonate sand.
Upper Slope	The slope below 150 meters accumulates finer bank-top sediments as well as planktonic components. The deposits are generally a medium-to-coarse sand with little mud. Larger grains include rhodoliths and worm tubes from the shelf as well as pteropods from the plankton. Heavy minerals (terrigenous source) are obvious in the finer fractions.

Caribbean Platforms

Figure 12

Schematic classification of carbonate platforms from the Caribbean Sea. Platforms are indicated on a cross-plot of bank area vs average bank depth. In general, small and deep platforms are viewed as "drowners" - those which have been unable to keep up, biologicallyand sedimentologically, with sea-level rise. Larger and shallower banks usually show evidence of "shedding" - i.e., overproduction and export of biogenic sediment from the bank top even during sea-level rise. The Salvage Island Platforms are small and deep placing them in the lower left corner of the plot where "hybrid" characteristics are typical. Figure from Wilber, 1992.



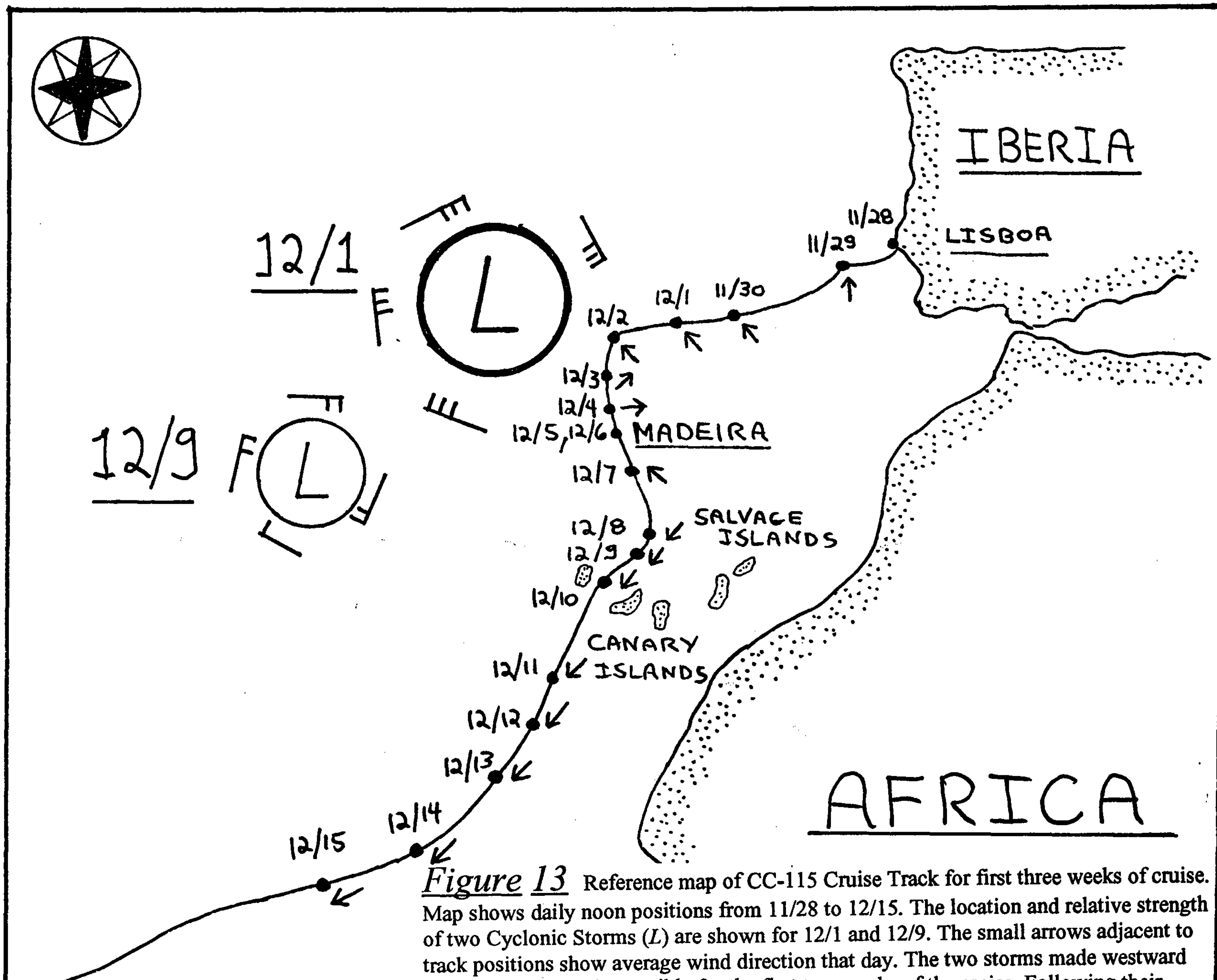


Figure 13 Reference map of CC-115 Cruise Track for first three weeks of cruise. Map shows daily noon positions from 11/28 to 12/15. The location and relative strength of two Cyclonic Storms (*L*) are shown for 12/1 and 12/9. The small arrows adjacent to track positions show average wind direction that day. The two storms made westward motion difficult or impossible for the first two weeks of the cruise. Following their passage the Trade Winds filled in nicely (12-8 to 12-15) and we were on our way across the Atlantic. Map and data from Auerbach, Burt and Scheirer.

<u>*Figure 14*</u>

Summary of Air Temperature (T_A) data collected on CC-115 during first three weeks of the cruise.

Figure 14A shows plot of T_A vs Distance as measured by the ship's log. The figure demonstrates the "Big Picture" trend of temperature during this time - that of increasing temperature with increasing mileage which, in the case of CC-115, was directly correlated with decreasing latitude.

Figure 14B is a plot of T_A vs Cruise Hours. This figure shows an initial rapid rise in temperature as CC-115 left the Tagus River and Portuguese shelf. The slow rise in temperature around 100 hours is the latitudinal trend. The "spike" near 230 hours is related to the second of two storms we experienced during this time. The latter part of the lot shows the latitudinal gradient with considerable daily variability.

Figure 14C is a expanded plot of T_A vs Cruise Hours used to investigate daily temperature cycling over the subtropical ocean. The data reveal a diel cycle (one high and one low per 24 hour period) which makes the overall T_A data trend appear as a "climbing sign wave". The magnitude of daily change is 2°C with the daily high occurring in the late afternoon.

All graphs and analysis by Aurbach, Burt, Scheirer and Lovett.

Figure 14A
T_A vs Log

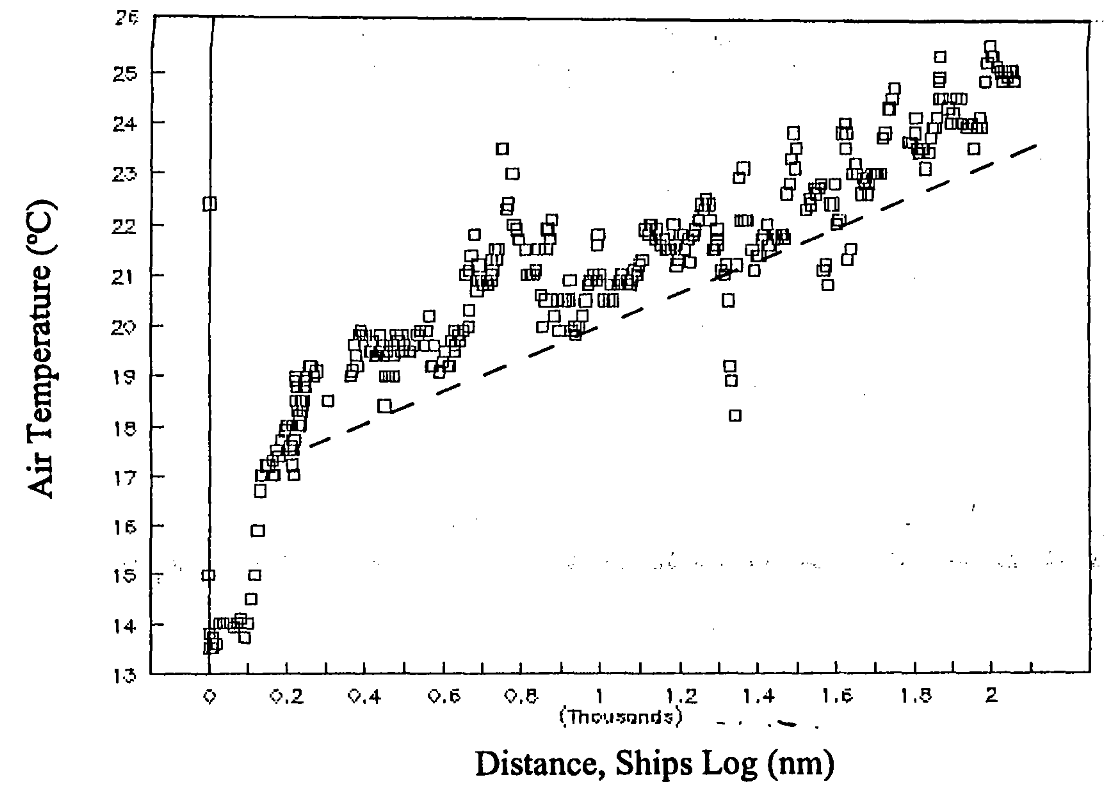


Figure 14B
T_A vs Cruise Hour

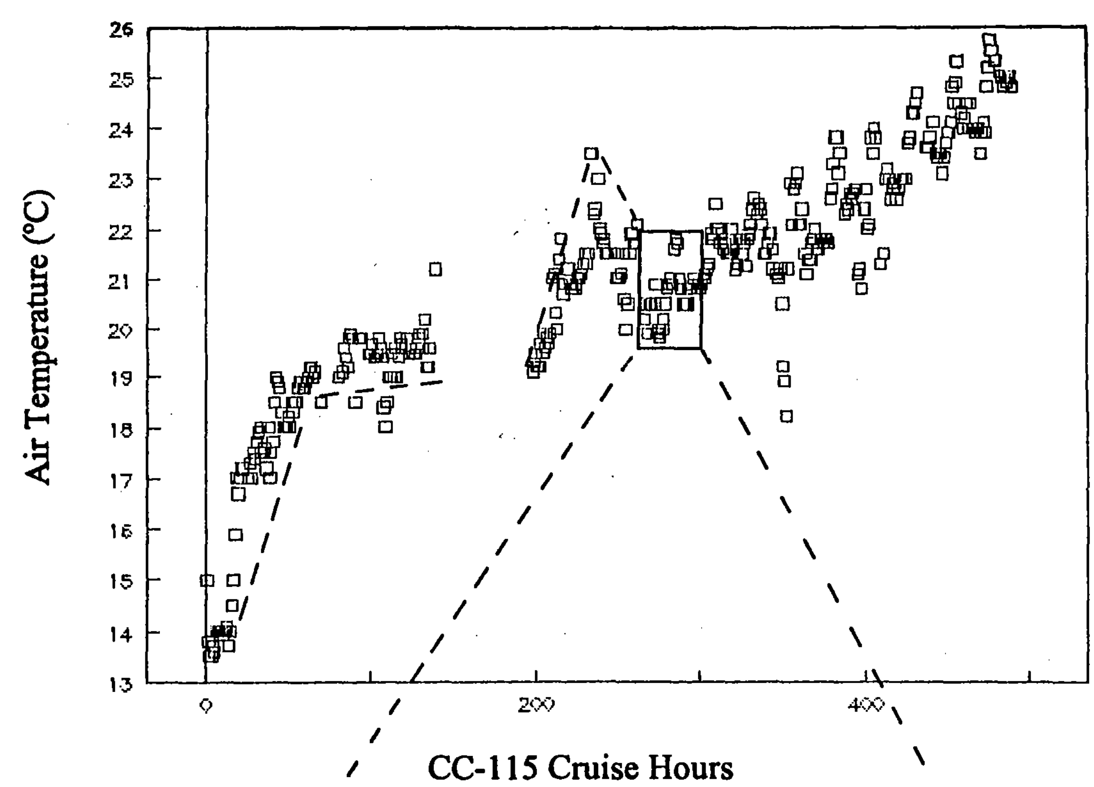


Figure 14C
T_A vs Cruise Hour

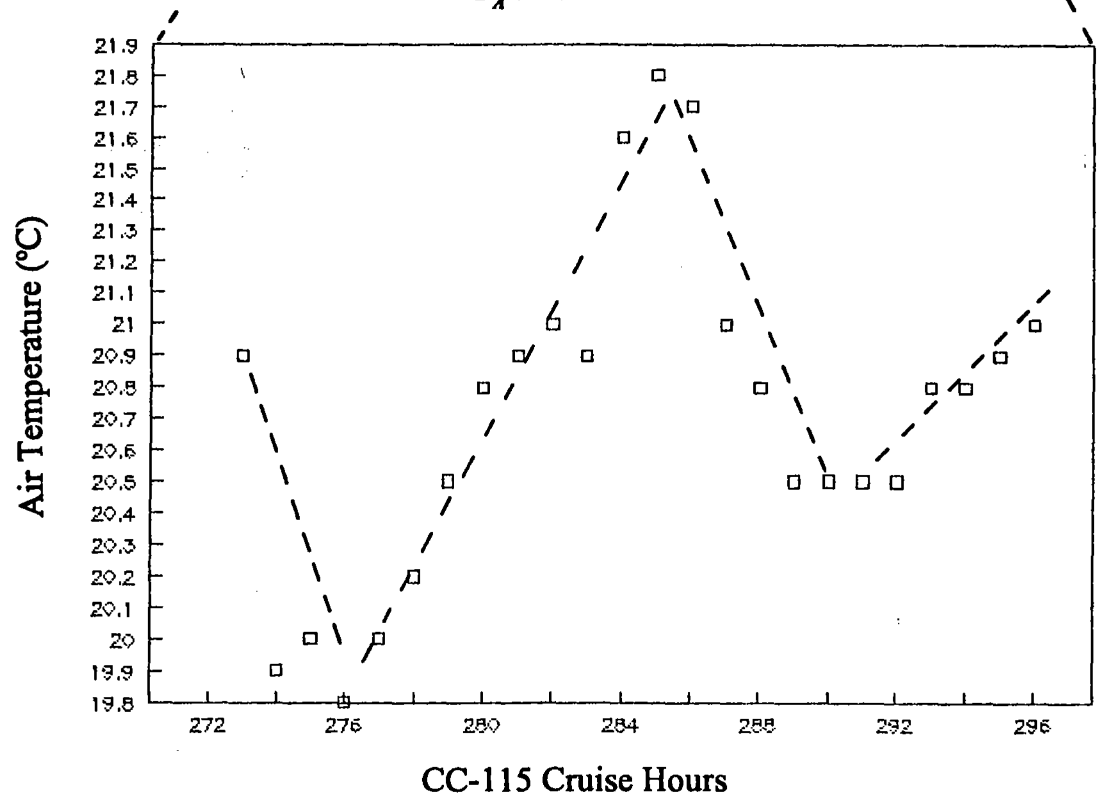


Figure 15

Summary of Sea Surface Temperature (T_S) data collected on CC-115 during first three weeks of the cruise.

Figure 15A shows plot of T_S vs Cruise Hours. The figure demonstrates the "Big Picture" trend of temperature during this time - that of increasing temperature with increasing mileage which, in the case of CC-115, was directly correlated with decreasing latitude.

Figure 15B is an expanded plot of T_S vs Cruise Hours which clearly shows that the latitudinal trend on rising temperature appears a climbing sign wave indicative of higher-order structure in the temperature data.

Figure 15C is a expanded plot of T_S vs Cruise Hours used to investigate daily temperature cycling in the surface subtropical ocean. The data reveal a diel cycle (one high and one low per 24 hour period). The magnitude of daily change is 1°C with the daily high occurring in the late morning or early afternoon.

All graphs and analysis by Aurbach, Burt, Scheirer and Lovett.

Figure 15A

SST vs Cruise Hour

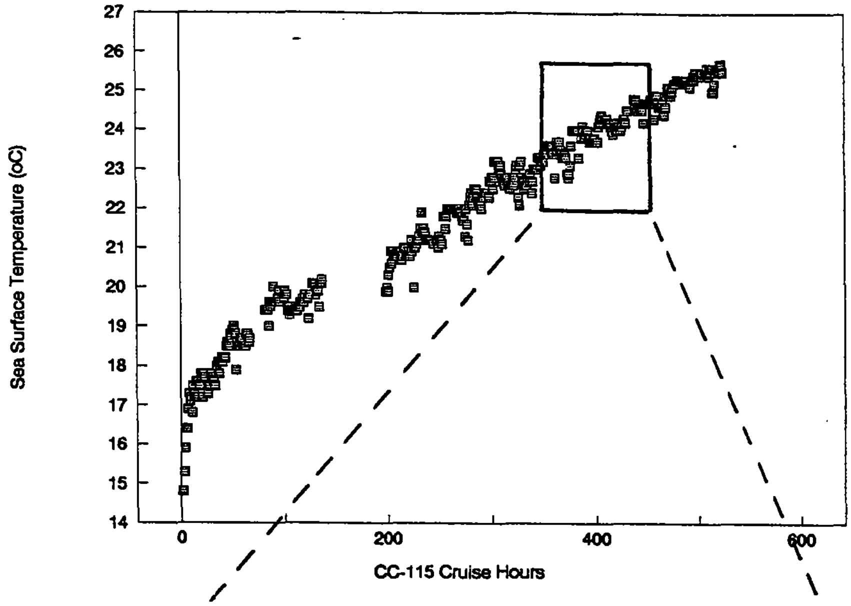


Figure 15B

SST vs Cruise Hour

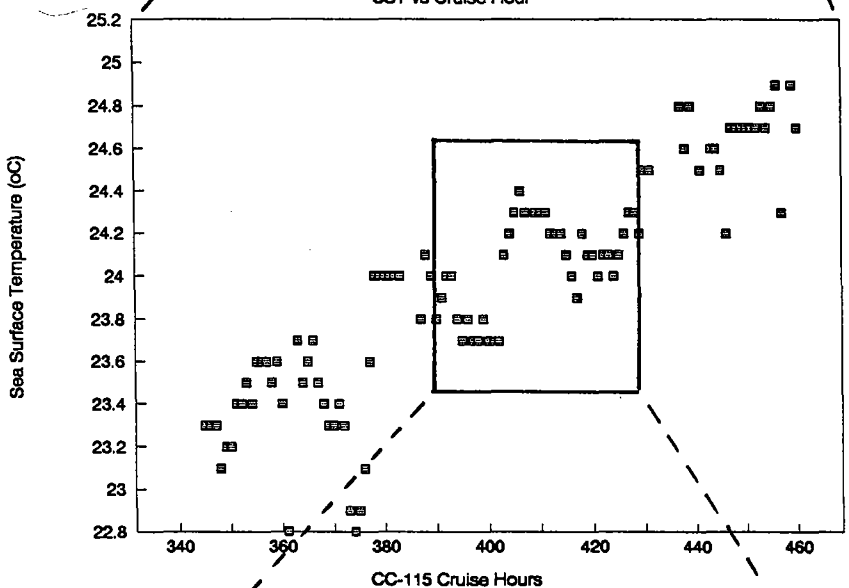


Figure 15C

SST vs Cruise Hour

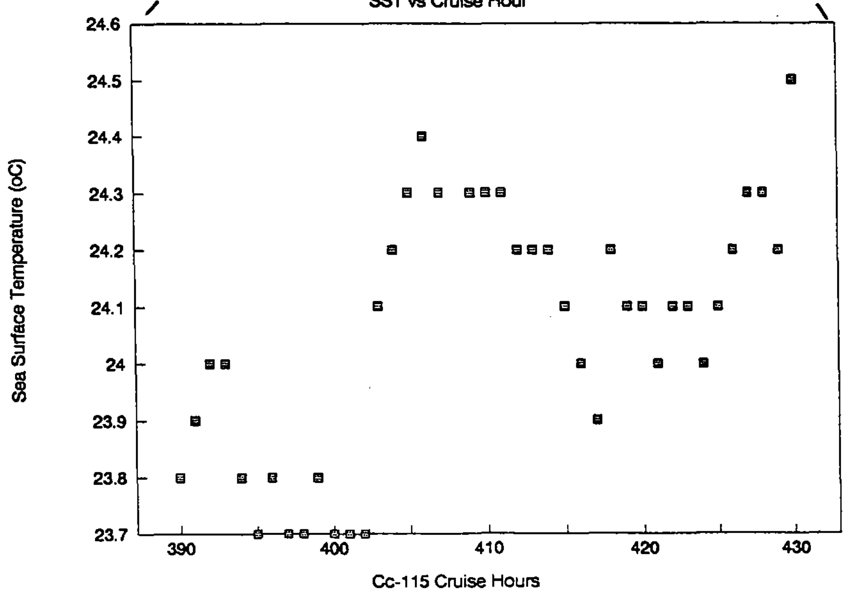


Figure 16

Summary of Barometric Pressure (P_B) and Beaufort (F_B) data collected on CC-115 during first three weeks of the cruise.

Figure 16A shows plot of P_B vs Cruise Hours. The figure demonstrates the "Big Picture" trend of P_B during this time - that of increasing pressure with increasing time which, in the case of CC-115, was directly correlated with decreasing latitude. In general the P_B data is dominated by a series of fluctuations which are directly related to "mesoscale" atmospheric events experinced during this time. Of particular note is the extreme low pressure experience on the fourth day of the cruise as the large Low depicted in Figure 13 struck CC-115.

Figure 16B is an expanded plot of P_B vs Cruise Hours which clearly shows that the "fuzzy envelope" of values which typifies the subtropical ocean portion of Figure 16A (right) exhibits higher-order cyclycity. In this case the cycles are diurnal (two highs and two lows during a 24 hour period). For the Eastern Subtropical Atlantic in early December, 1991 these daily barometric tides showed "eleven o'clock highs" - i.e. maximum barometric pressure near 1100 and again at 2300. The magnitude of the barometric tide is appproximately 2 mb.

Figure 16C is a plot of F_B vs Cruise Hours used to investigate the correlation between P_B and F_B. This plot in conjunction with 16A visually show an inverse correlation between P_B and F_B. Most notable is the match of highest winds speed (B_F=9) with lowest P_B (1002 mb). This relationship is expanded on in Figure 17.

All graphs and analysis by Aurbach, Burt, Scheirer and Lovett.

Figure 16A

P_B vs Cruise Hour

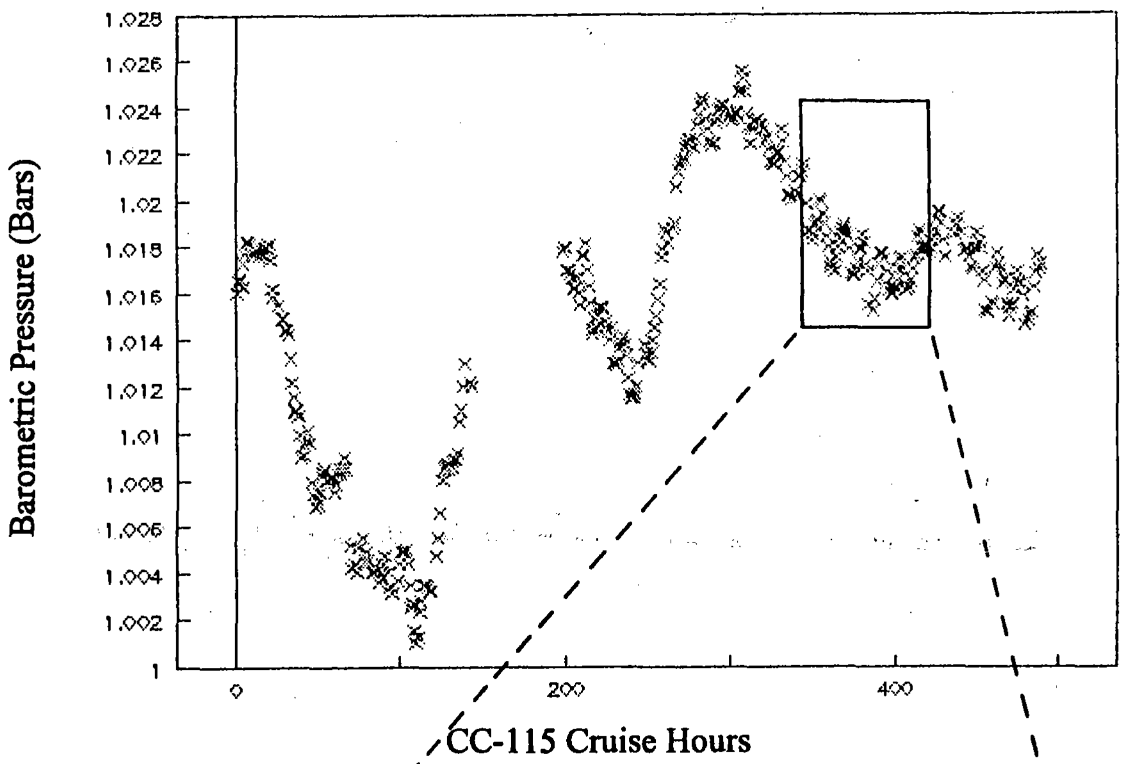


Figure 16B

P_B vs Cruise Hour

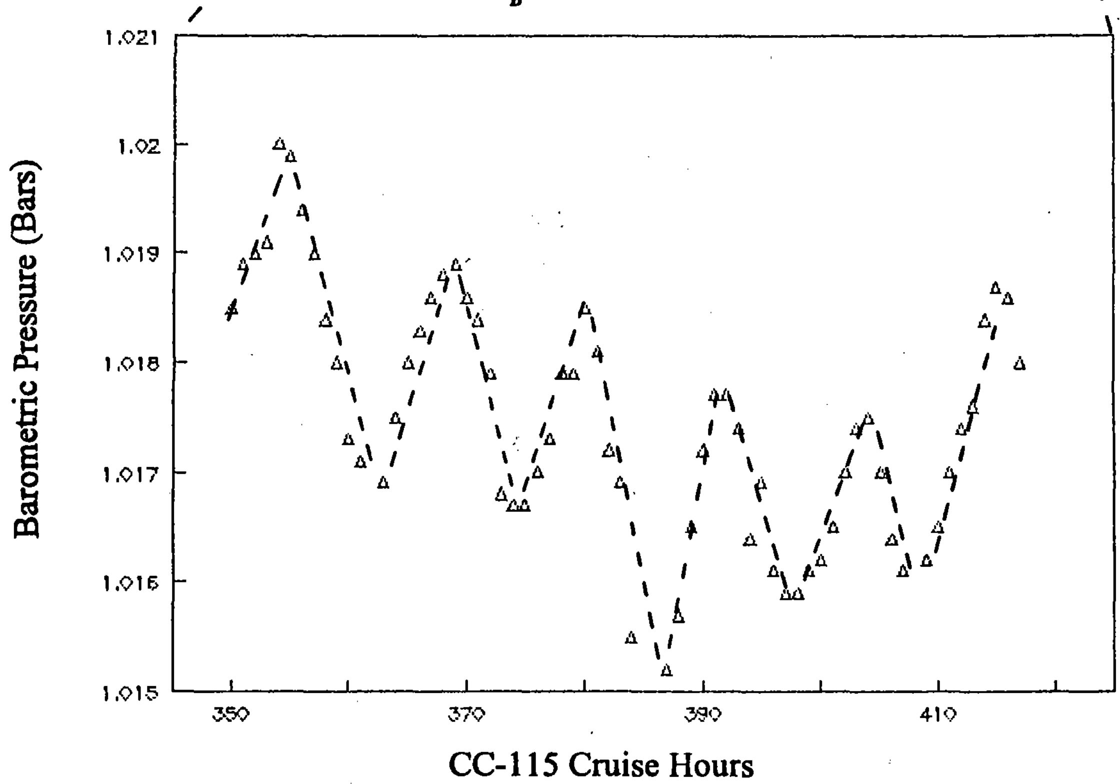


Figure 16C

F_B vs Cruise Hour

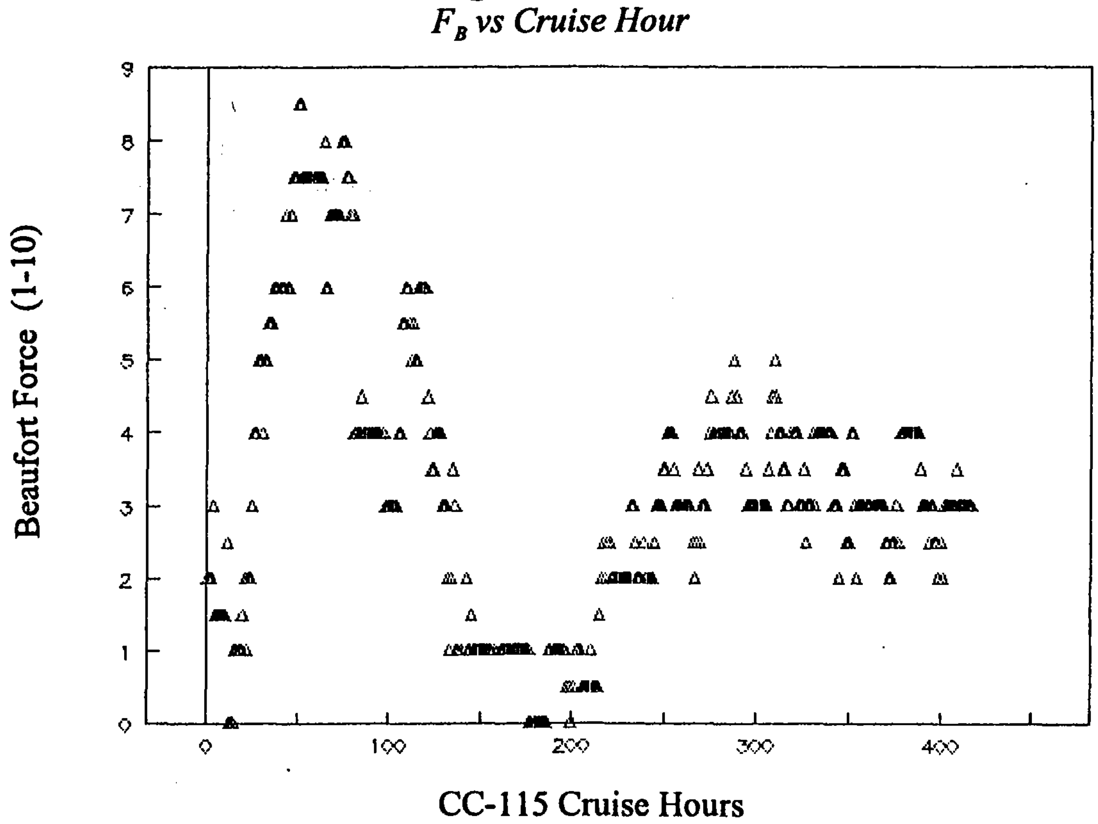


Figure 17

B_p vs F_B

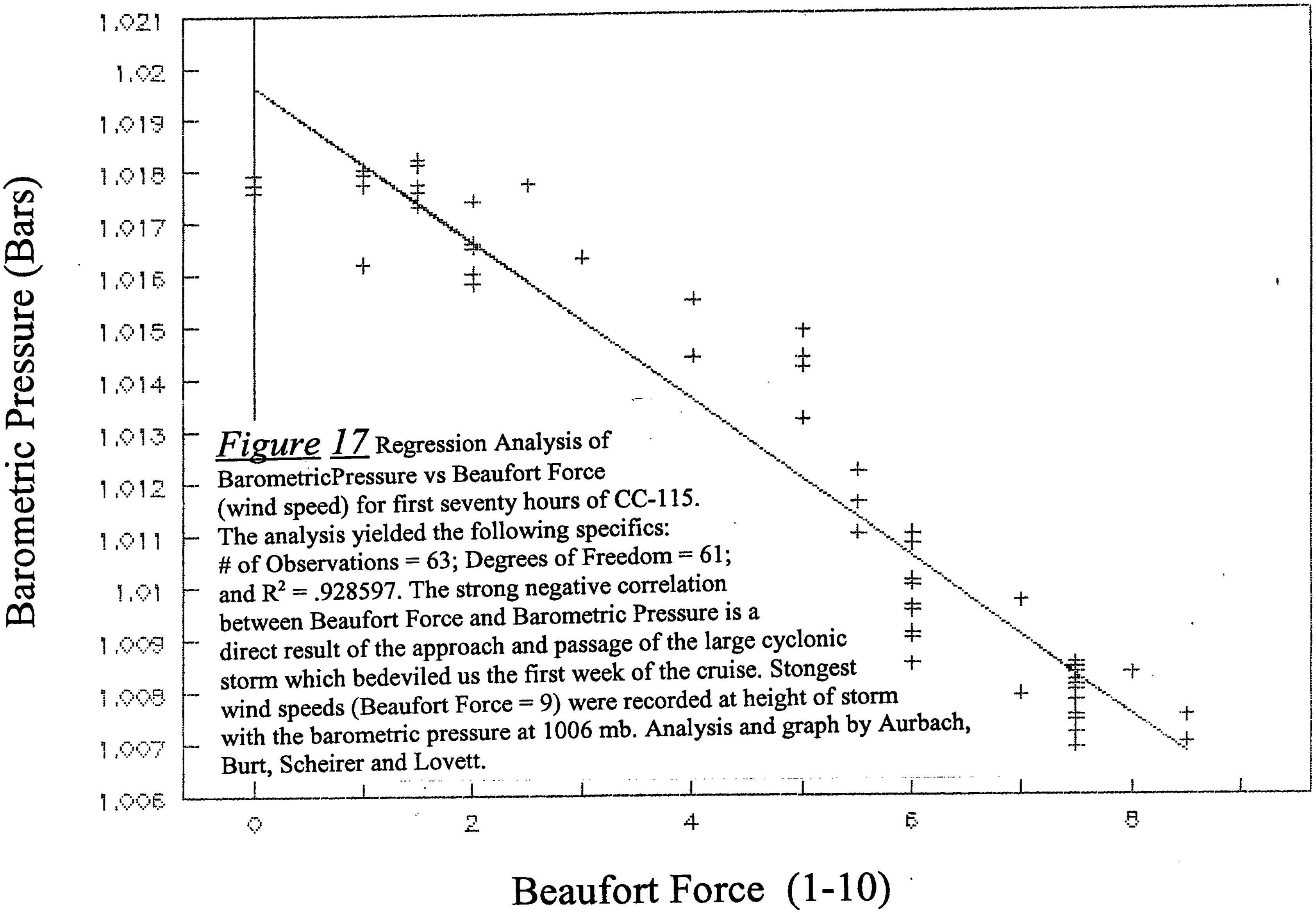


__Figure__ *__17__* Regression Analysis of BarometricPressure vs Beaufort Force (wind speed) for first seventy hours of CC-115. The analysis yielded the following specifics: # of Observations = 63; Degrees of Freedom = 61; and R^2 = .928597. The strong negative correlation between Beaufort Force and Barometric Pressure is a direct result of the approach and passage of the large cyclonic storm which bedeviled us the first week of the cruise. Stongest wind speeds (Beaufort Force = 9) were recorded at height of storm with the barometric pressure at 1006 mb. Analysis and graph by Aurbach, Burt, Scheirer and Lovett.

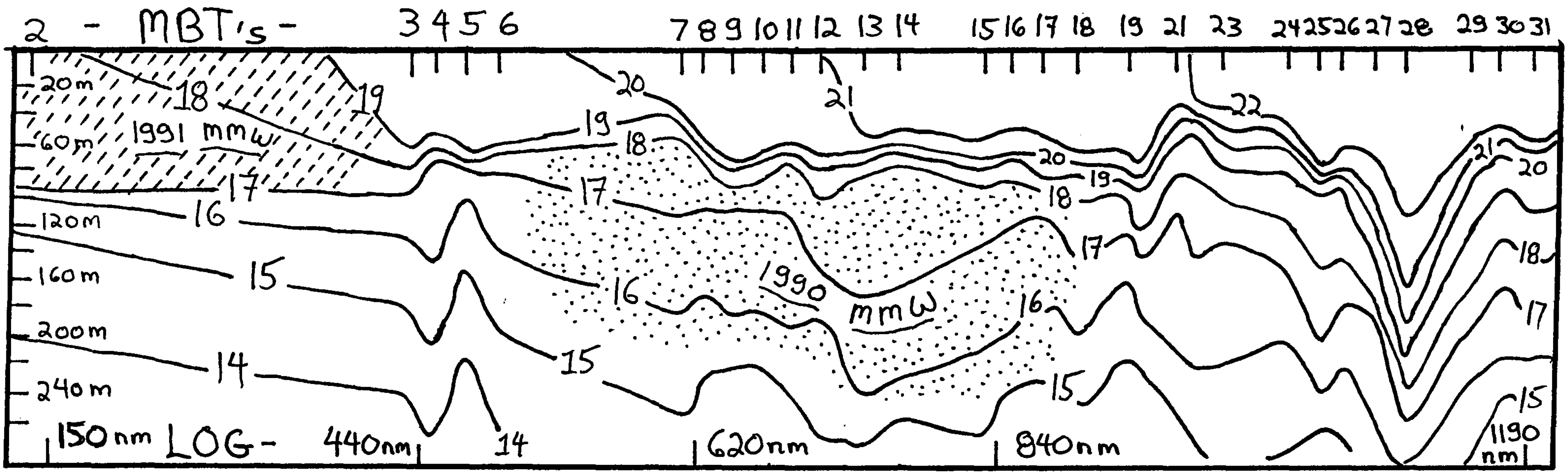


Figure 18 300-meter temperature section for first 1200 nm of CC-115. MBT numbers are given along top of section. Depth in meters is shown along the left edge. Periodic mile marks, according to ship's log, are given along the bottom. Contour interval is 1° C. This section was used primarily to examine the formation and movement of the Madeira Mode Waters (MMW) for 1990 and 1991. Results are discussed in text. Section compiled by Hotaling, Melendy and Cutler and Lovett.

Figure 19

Three temperature profiles illustrating Madeira Mode Waters (MMW) in the Eastern North Atlantic.

"A" is MBT-001 taken near the beginning of the temperature section shown in Figure 18. In this profile the upper, thick (100m) thermostad is the 1991 MMW as it forms at the surface.

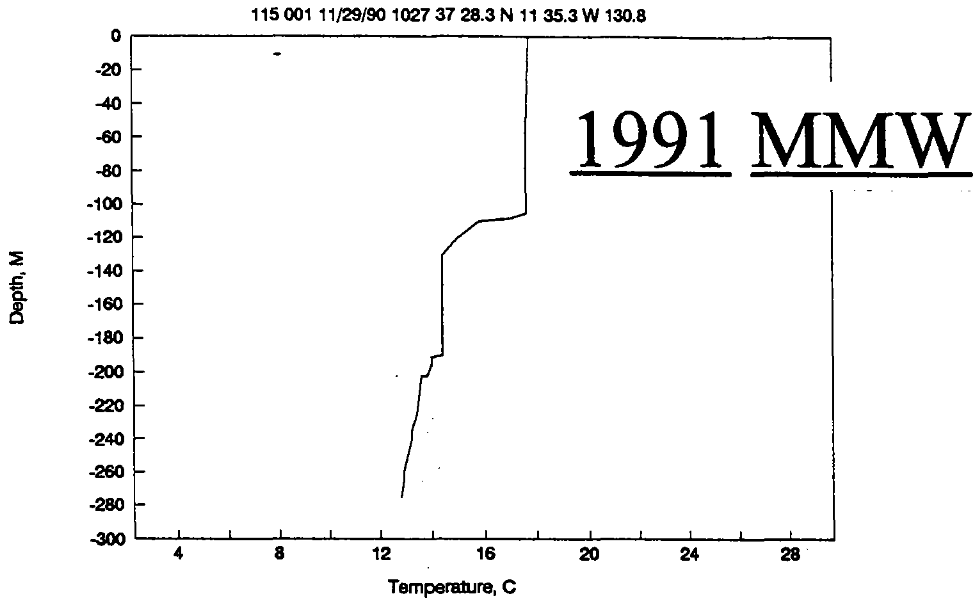
"B" is CTD-003 where the upper thermostad layer is subtropical surface water. The thin (30m) thermostad below the seasonal thermocline is the distal (northern) portion of the MMW for 1990.

"C" is CTD-008. Here, a 100m-thick layer of 1990 MMW is sealed below the seasonal thermocline and shows evidence of mixing both with the upper layer and the permanent thermocline below.

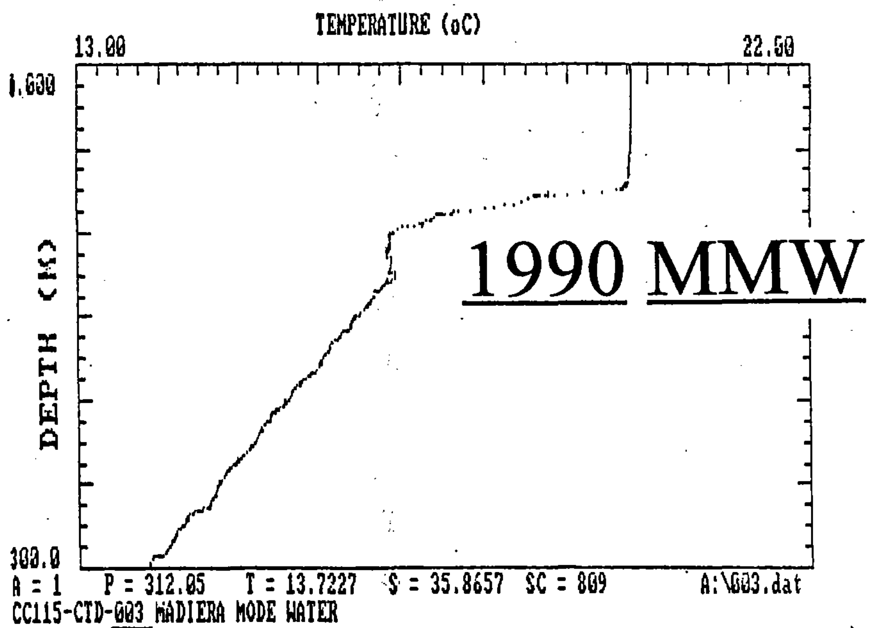
Graphs and interpretations by Hotaling, Melendy and Cutler and Lovett.

MBT-001

A


115 001 11/29/90 1027 37 28.3 N 11 35.3 W 130.8
1991 MMW
Depth, M
Temperature, C

B


TEMPERATURE (oC)
13.00
22.00
1.000
300.0
1990 MMW
DEPTH (M)
A = 1 P = 312.05 T = 13.7227 S = 35.8657 SC = 809 A:\003.dat
CC115-CTD-003 MADIERA MODE WATER

C

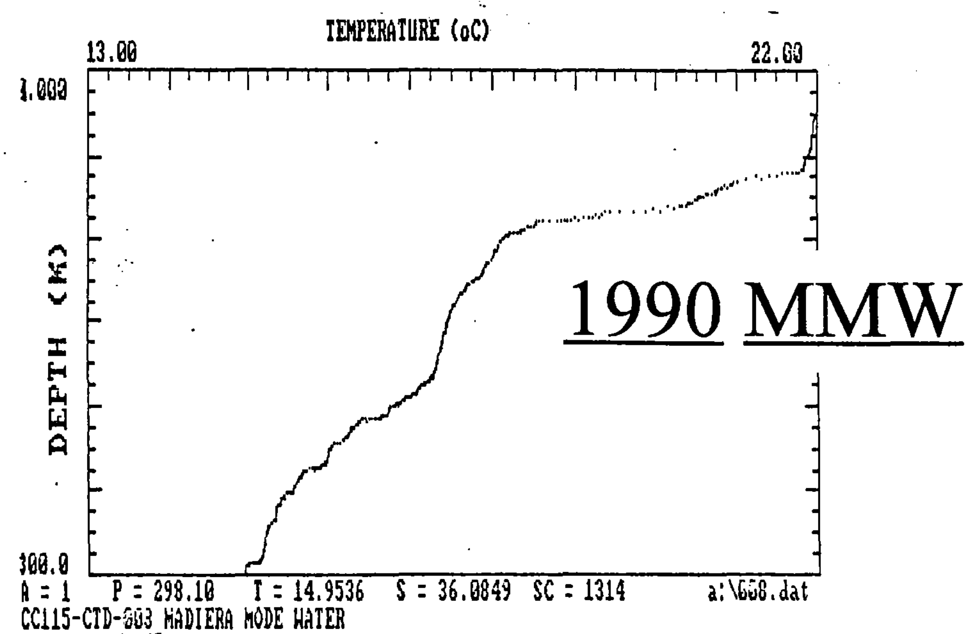

TEMPERATURE (oC)
13.00
22.00
1.000
300.0
1990 MMW
DEPTH (M)
A = 1 P = 298.10 T = 14.9536 S = 36.0849 SC = 1314 a:\008.dat
CC115-CTD-003 MADIERA MODE WATER

Figure 20

2000-meter temperature section for first 2000 nm of CC-115. "A" section is hand-contoured; "B" is same data set contoured with Surfer software. CTD numbers are given along the top of "A" section. Distance in nautical miles, according to ship's log, is shown along bottom of sections. These data were primarily used to examine the occurrence and distribution of Mediterranean Overflow Water in the Eastern North Atlantic. Results are discussed in text. Section compiled by Macdonald, Gutreuter, Cochrane and Kenna.

Figure 21

2000-meter salinity sections for the first 2000 nm of CC-115. "A" section is hand-contoured; "B" is same data set contoured with *Surfer* software. CTD numbers are given along the top of "A" section. Distance in nautical miles, according to ship's log, is shown along bottom of sections. These data were primarily used to examine the occurrence and distribution of Mediterranean Overflow Water in the Eastern North Atlantic. Results are discussed in text. Section compiles by MacDonald, Gutreuter, Cochrane and Kenna.

Figure 22

2000-meter density sections for the first 2000 nm of CC-115. "A" section is hand-contoured; "B" section is same data set contoured with *Surfer* software. CTD numbers are given along the top of "A" section. Distance in nautical miles, according to ship's log, is shown along bottom of the sections. Results are discussed in the text. Sections compiled by MacDonald, Gutreuter, Cochrane and Kenna.

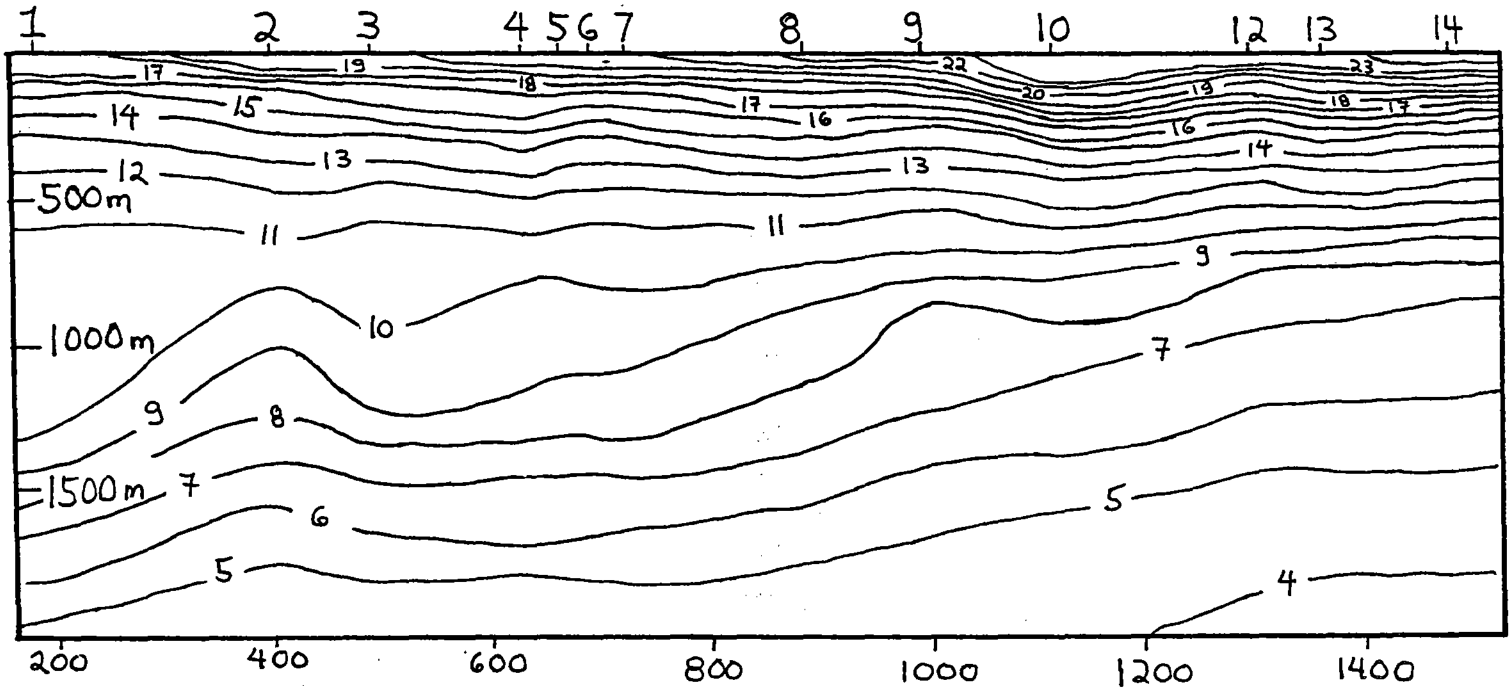
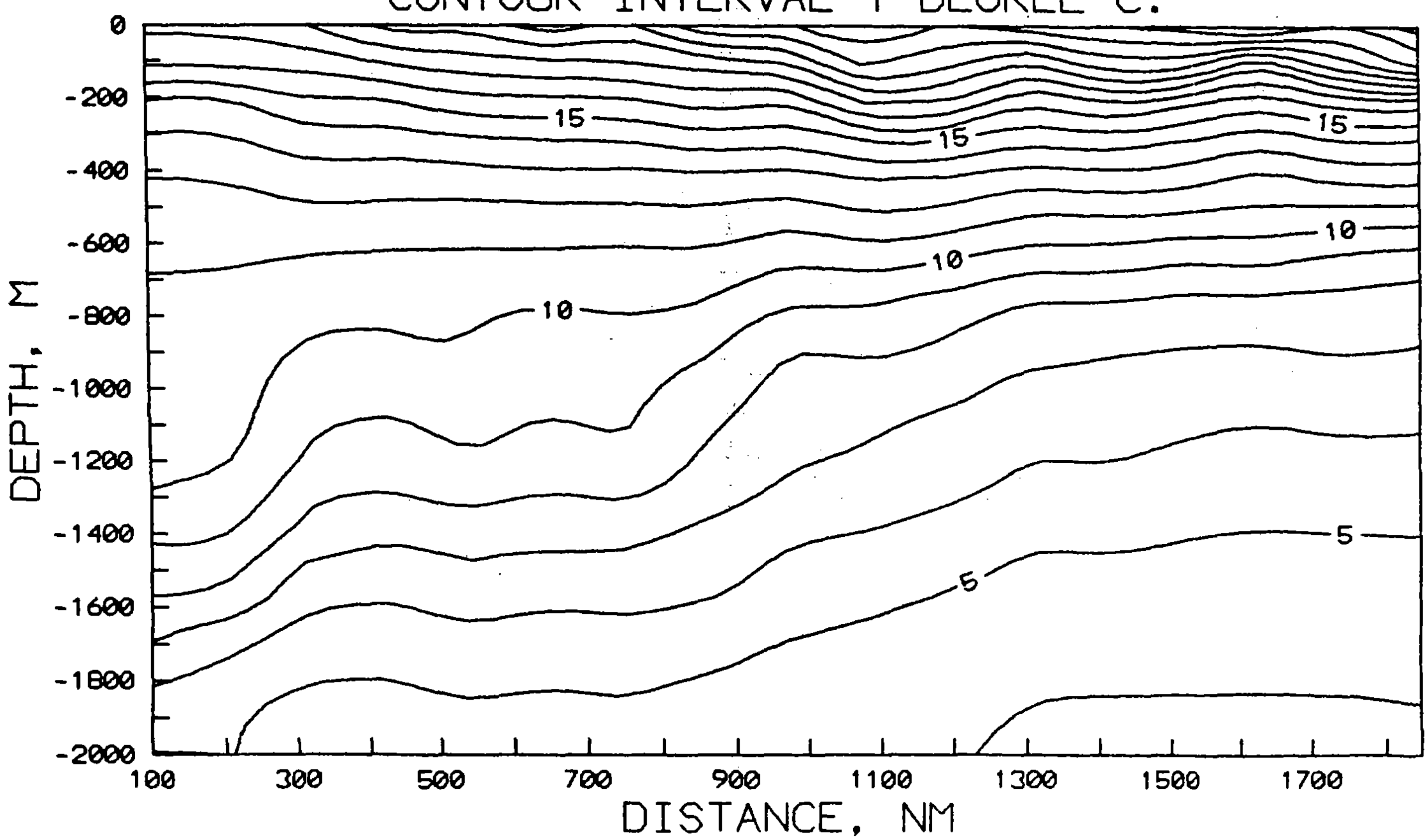


Figure 20A

Figure 20B

C115 TEMPERATURE SECTION CTD 001-016

CONTOUR INTERVAL 1 DEGREE C.



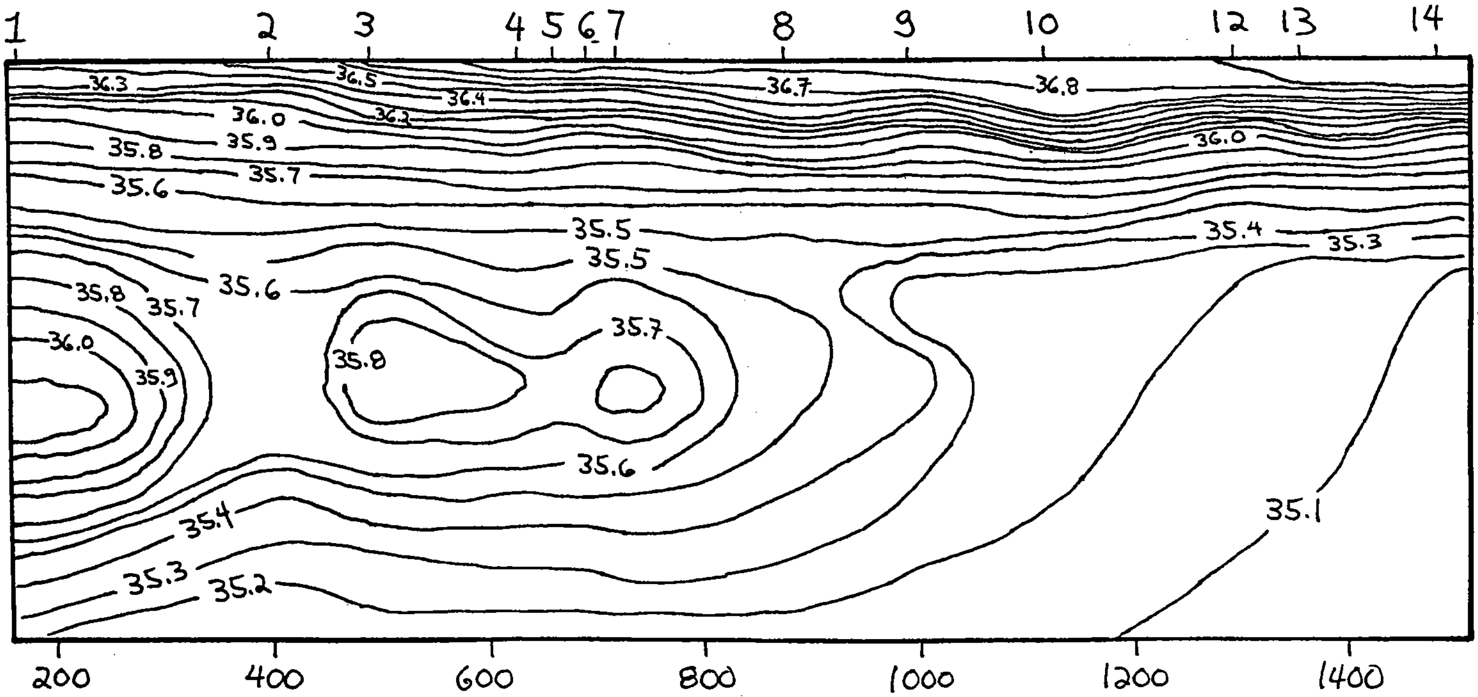
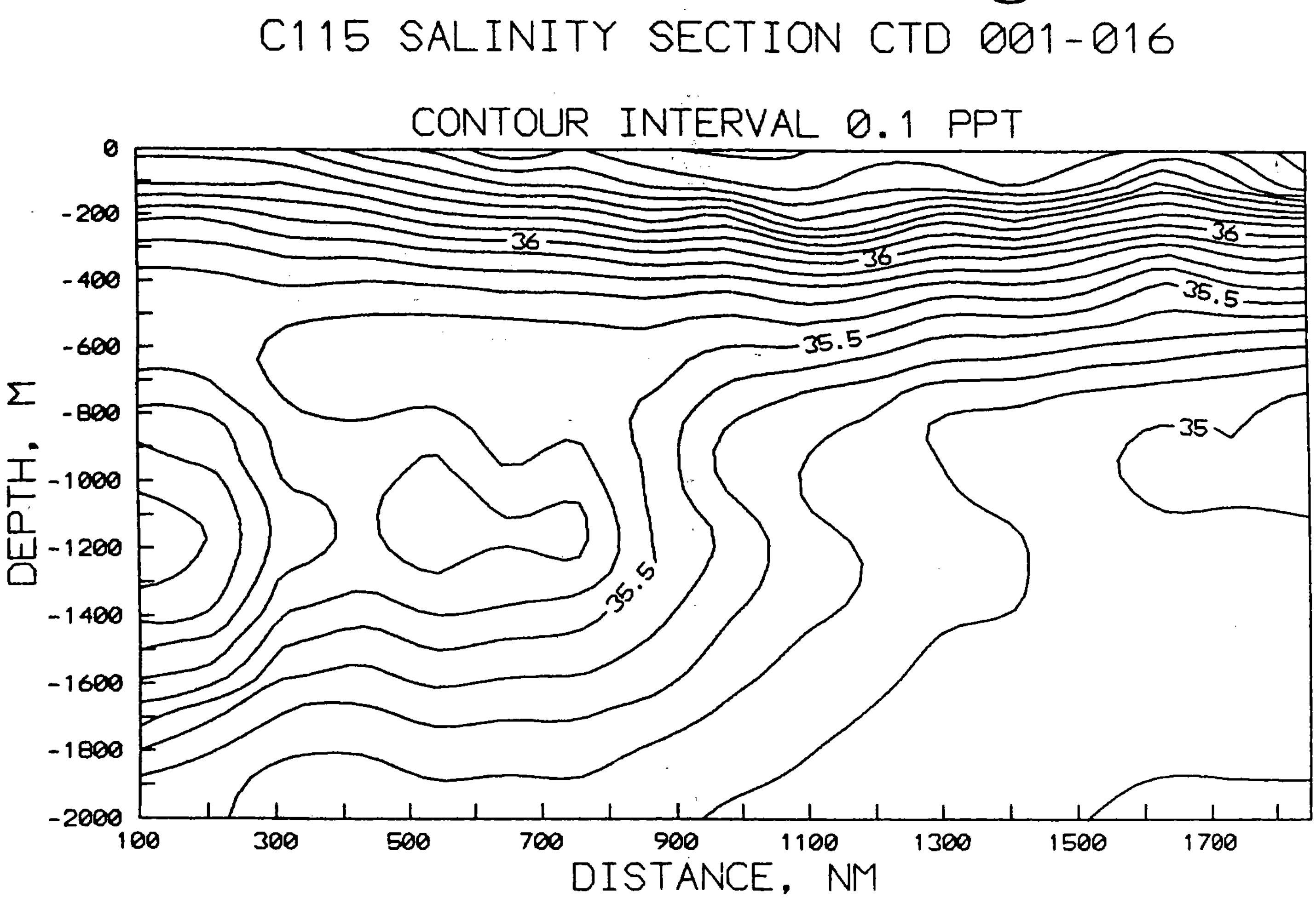


Figure 21A

Figure 21B



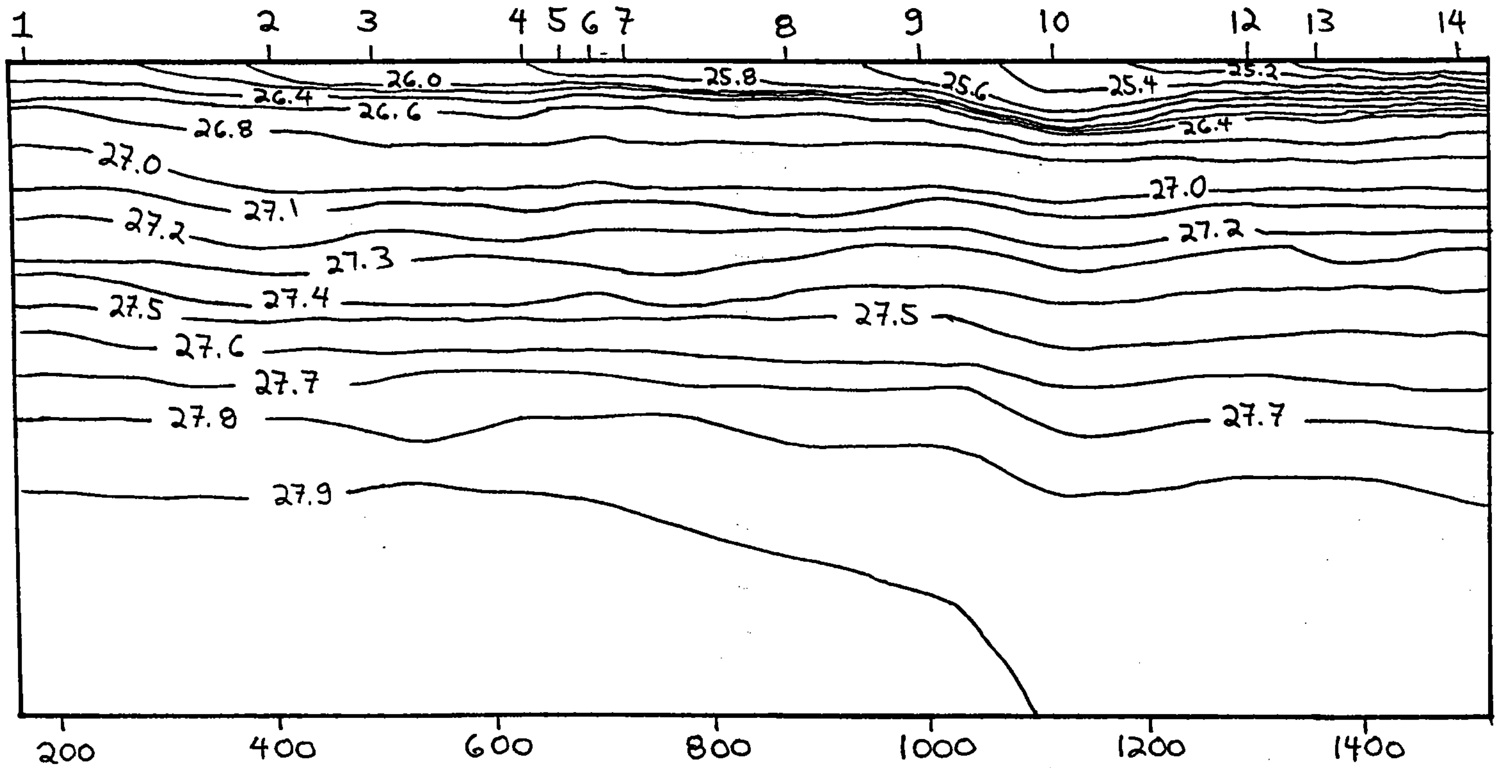


Figure 22A

Figure 22B

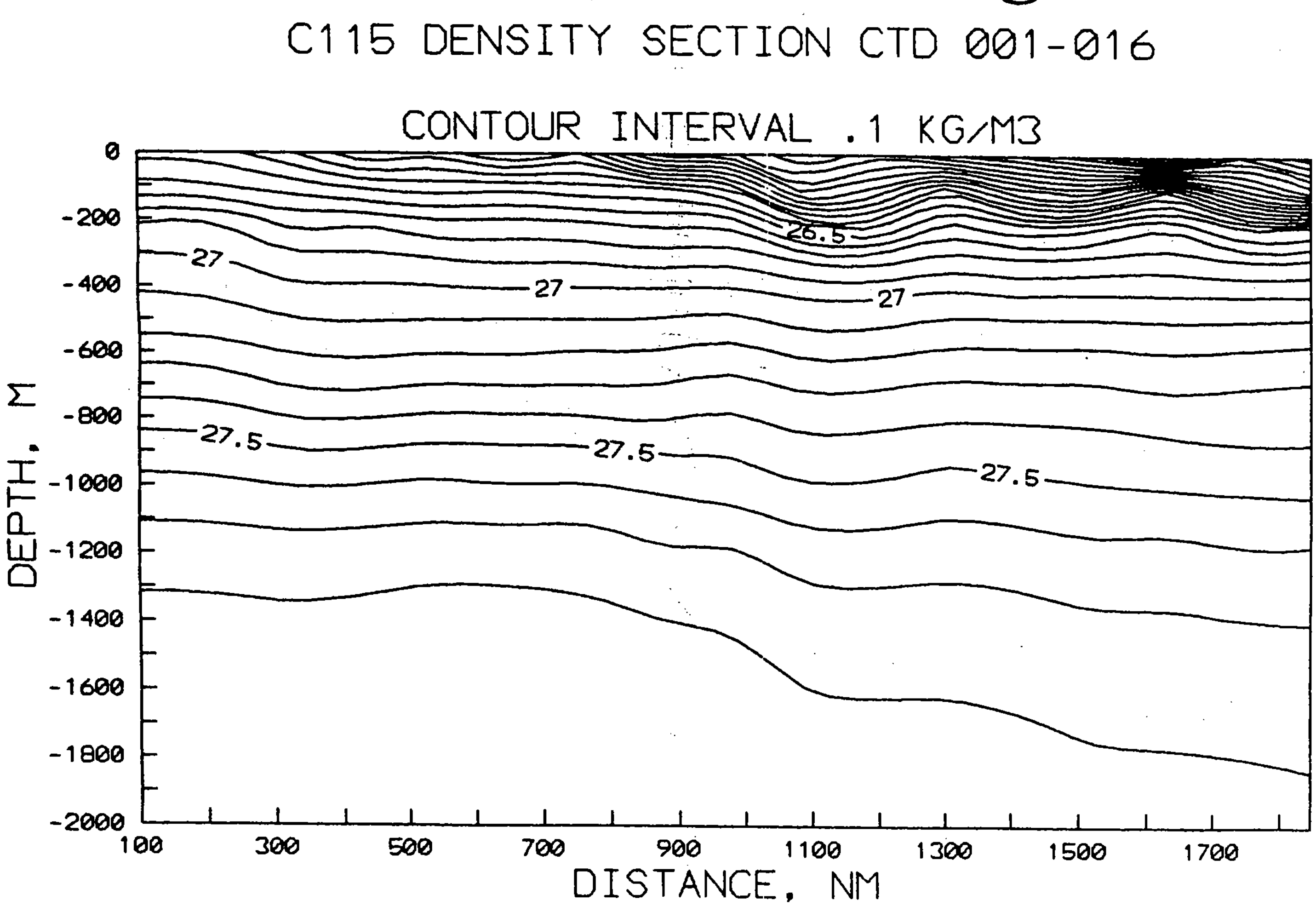


Figure 23

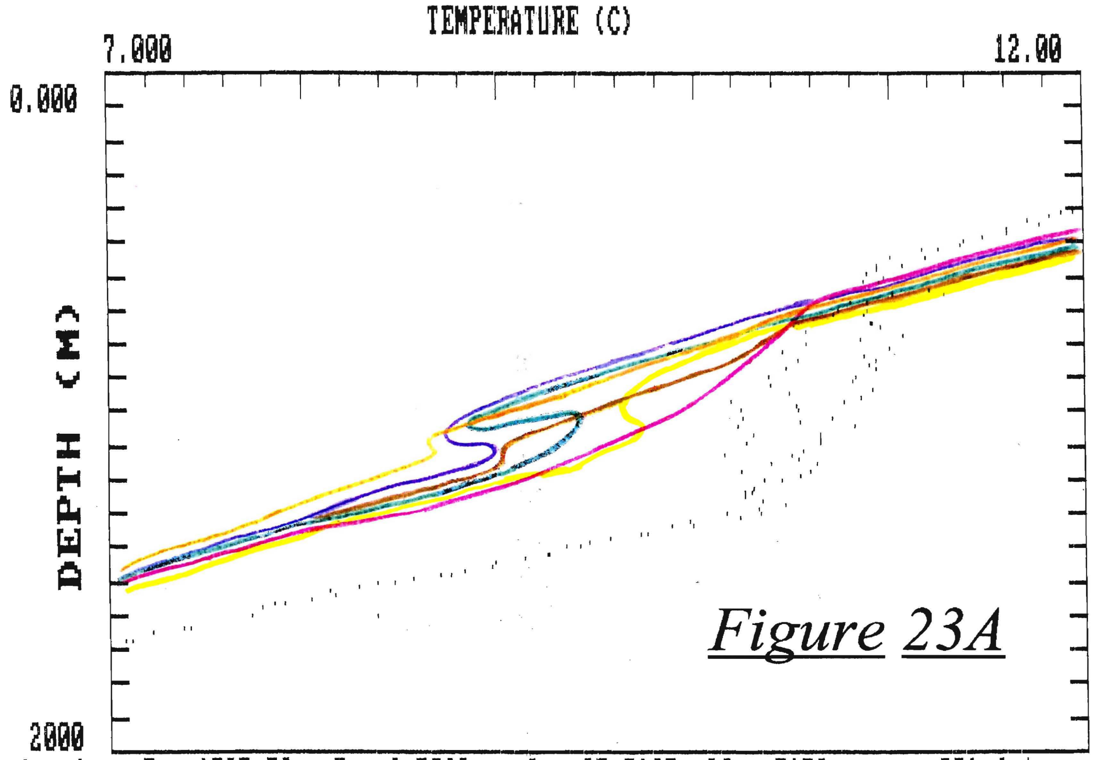
A Temperature-Depth plot for Core of Mediterranean Water and Meddies investigated during CC-115. Scatter plot of data shown is for CTD-001. The trends of scatter plots for six other CTDs in the 7-12° C temperature range are depicted as a series of colored lines. In this and the next three figures the following colors are used. Red: CTD-001; Orange: CTD-002; Fuchsia: CTD-003; Green; CTD-004; Violet: CTD-005; Brown: CTD-006 and Yellow: CTD-007. Results are discussed in the text. Graph compiled by Rand, Kinney, Gallagher and Lyman.

B Density-Depth plot for core of Mediterranean Water and Meddies examined during CC-115. Scatter plot of data shown is for CTD-001. The trends of the scatter plots for six other CTDs in the 27-28 Sigma-θ range are shown as a series of colored lines. Results are discussed in the text. Graph compiled by Rand, Kinney, Gallagher and Lyman.

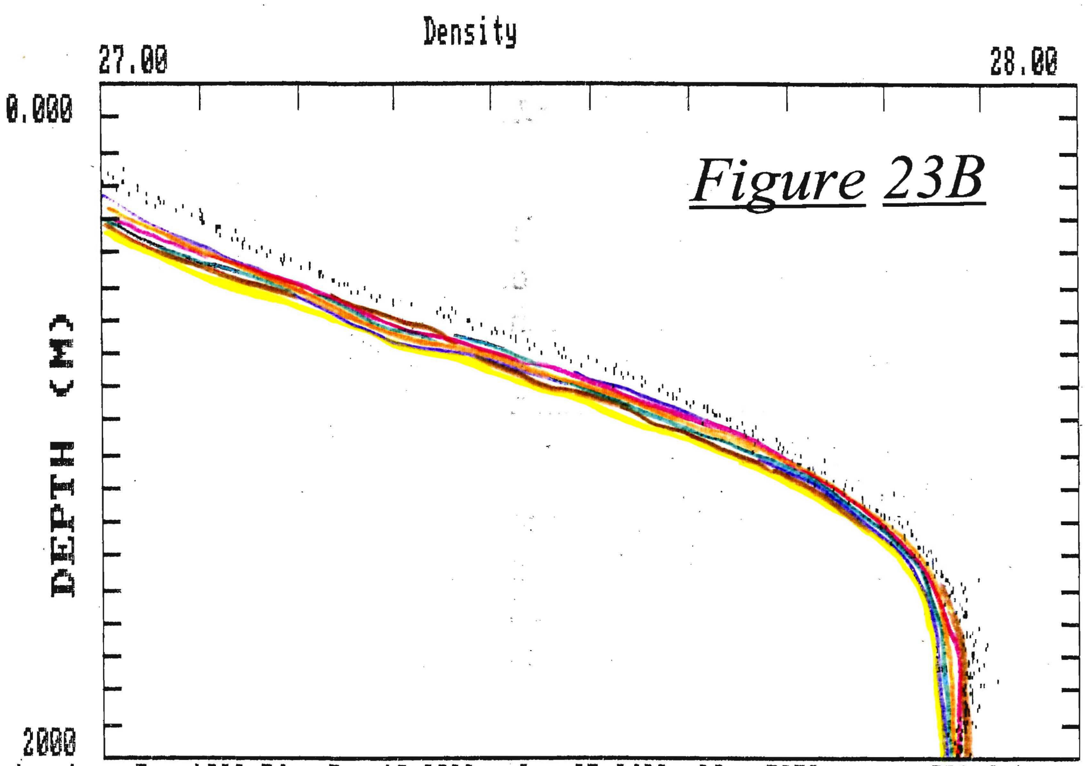
Figure 24

A Salinity-Depth plot for core of Mediterranean Water and Meddies examined during CC-115. Scatter plot of data shown is for CTD-010 which shows minor influence of MOW. The trends of the scatter plots for seven other CTDs in the 35-36.0 ppt range are shown as a series of colored lines. Results are discussed in the text. Graph compiled by Rand, Kinney, Gallagher and Lyman.

B Temperature-Salinity plot for core of Mediterranean Water and Meddies examined during CC-115. Scatter plot of data shown is for CTD-001. The trend of the scatter plots for six other CTDs in the 7-12 °C range are shown as a series of colored lines. Results are discussed in the text. Graph compiled by Rand, Kinney, Gallagher and Lyman.



A = 1 P = 1725.78 T = 6.7068 S = 35.5185 SC = 5152 001.dat
CC115-CTD-001, CORE TEMPERATURE STRUCTURE, MED. WATER, 37 9.8'N X 12 5.5'W.



A = 1 P = 1082.54 T = 10.3023 S = 35.9493 SC = 7879 001.dat
CC115-CTD-001 Density

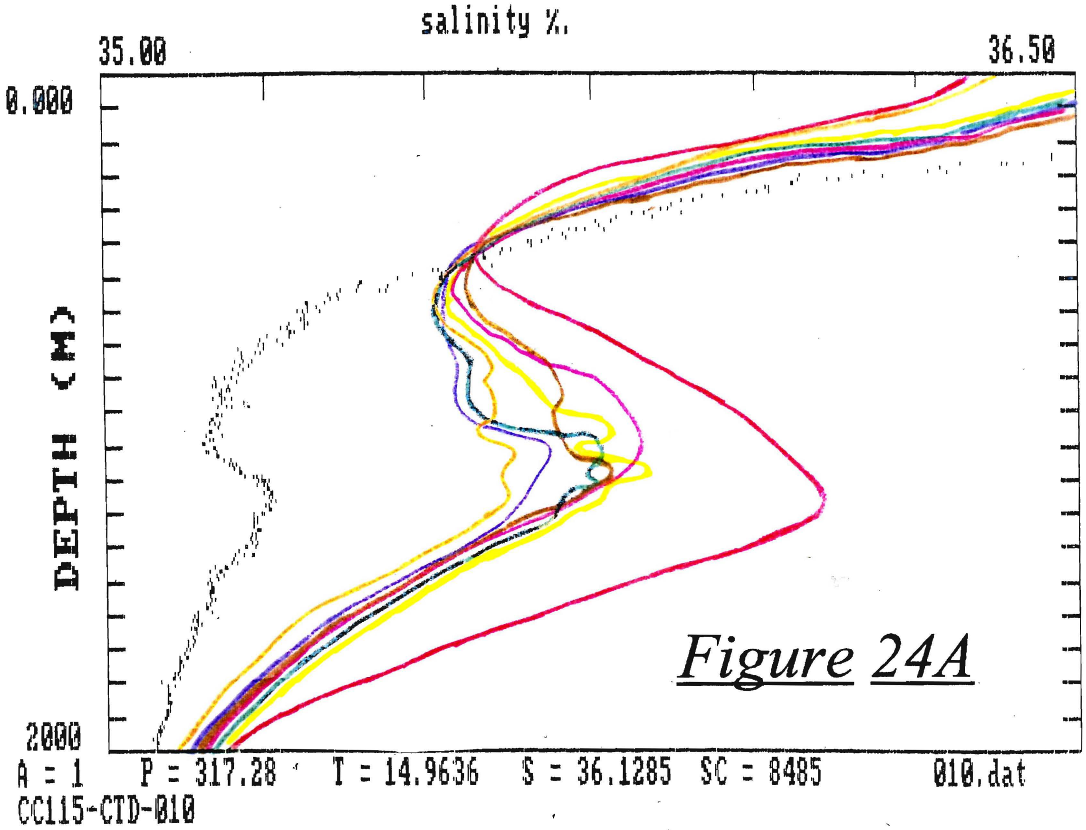


Figure 24A

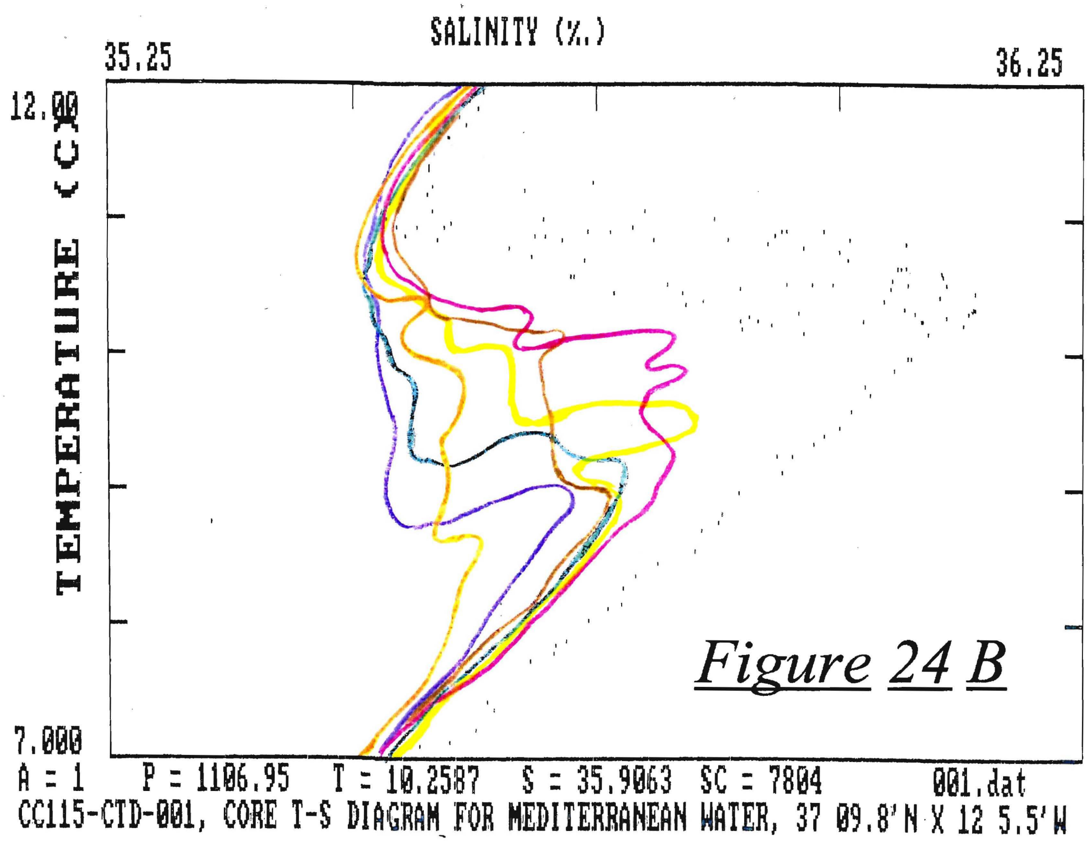


Figure 24 B

Figure 25

A Cross-plot of Surface Salinity (S_S) vs Cruise Hours for first 700 hours (to Antigua) of CC-115. In this graph the squares are values generated from Bottle 1 at each station; the crosses are from the second replicate (Bottle 2). In general, the surface salinity increases with time which, on CC-115, correlates with decreasing latitude. The major salinity trend here depicted is that of the regional, latitudinal gradient of the Eastern North Atlantic. There is abundant evidence of mesoscale feature sin the latter portion of the graph but these were not investigated.

B Plot of the difference in replicate S_S values determined via Salinometer during first 700 hours (to Antigua) of CC-115. Δ salinity value was determined by subtracting salinity value obtained for Bottle 1 from that obtained for Bottle 2 at each station. These data reveal good agreement between the values determined on replicate surface samples via this method. In general the Δ salinity value is >0.1 ppt.

Graphs by Busby, MacDonald, Cochrane and Kenna.

Figure 26

A Plot of Surface Salinity (S_S) vs Distance, as measured by the ship's log, for first 1500 nm of CC-115. In this plot the squares are S_S values determined with the CTD during deep hydrocasts. The crosses are the mean values of S_S determined by the two-bottle/salinometer method. In general, the CTD values obtained during steady measurements made at the surface agreed well with the bottle values.

B Plot of Surface Salinity (S_S) vs Distance as measured by the ship's log for first 3000 nm (to Antigua) of CC-115. In this plot the squares are the mean S_S values determined with the two-bottle/salinometer method. The crosses are S_S values obtained from surface water collected at each station and then measured with the CTD in a pickle bucket in the lab. In general the latter method produced widely divergent values as compared to values obtained from surface CTD measurements and the bottles.

Graphs by Busby, MacDonald, Cochrane and Kenna.

Figure 25A

Sal 1 and Sal 2 vs Cruise Hour

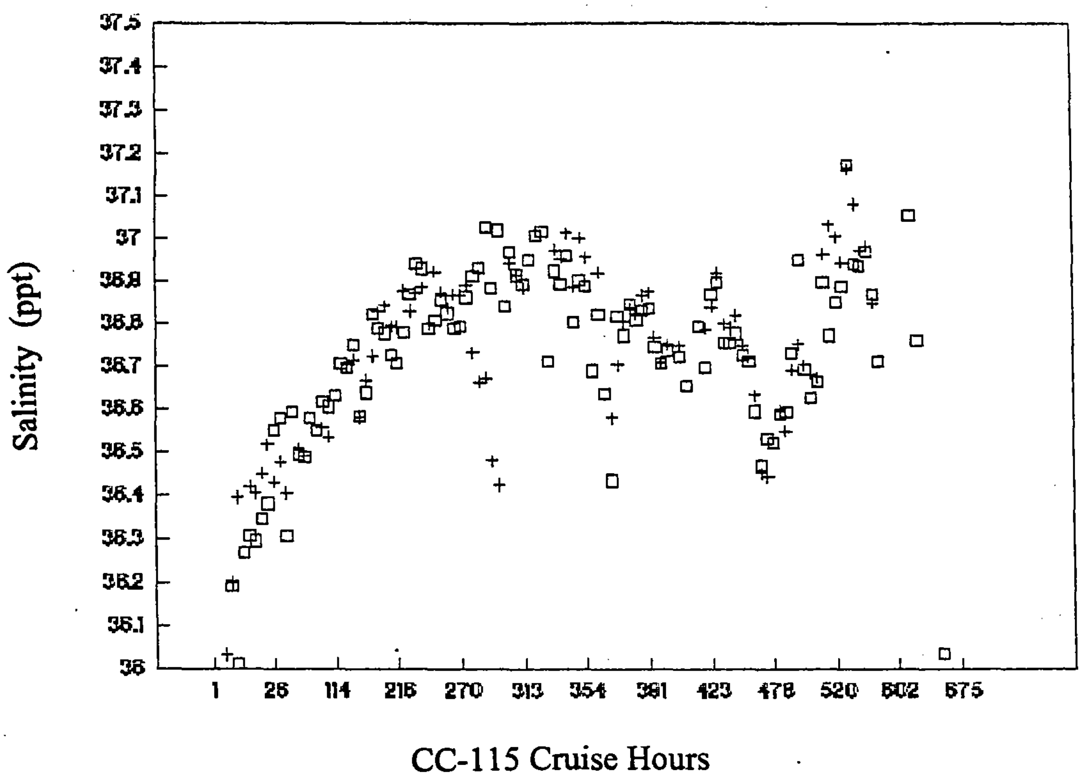


Figure 25B

Δ Salinity (Sal 1- Sal 2) vs Cruise Hour

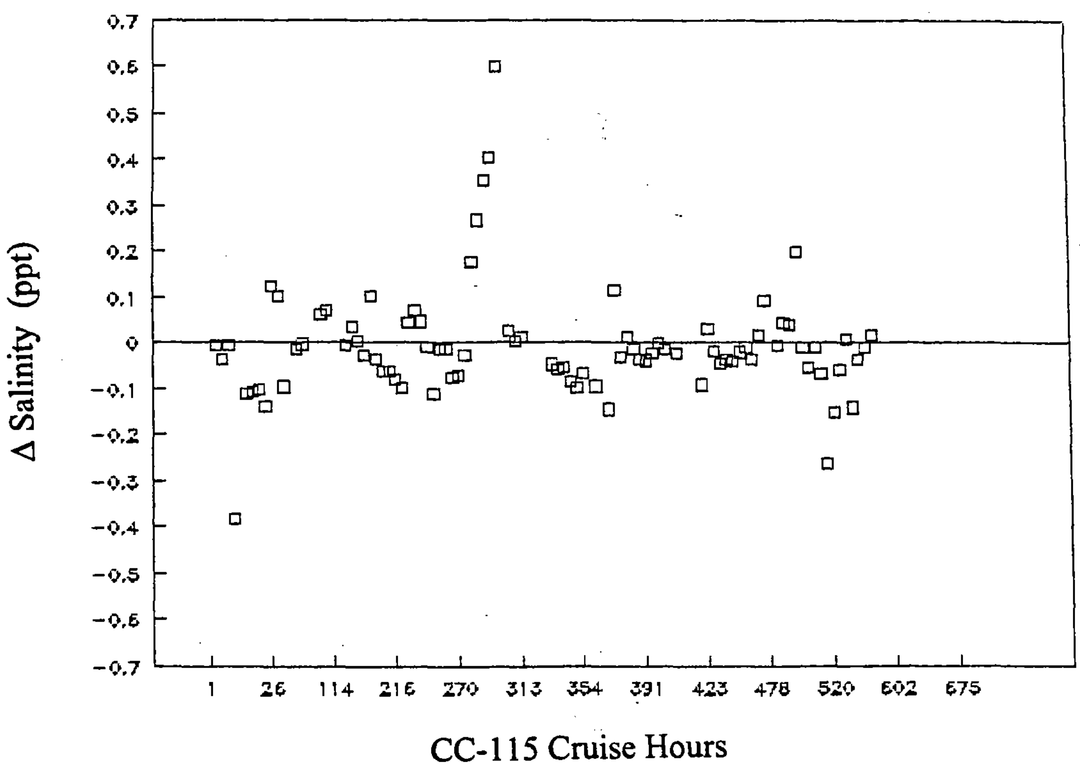


Figure 26A

Deep CTD SS and Average Bottle SS vs Log

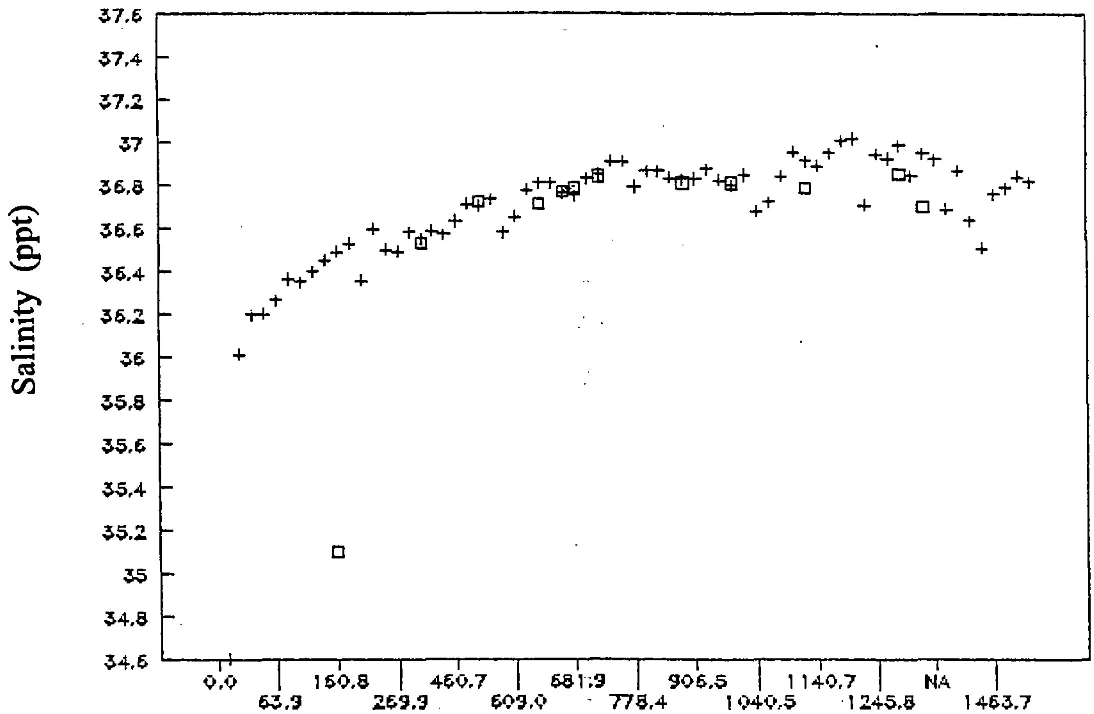


Figure 26B

Pickle Bucket CTD SS and Average Bottle SS vs Log

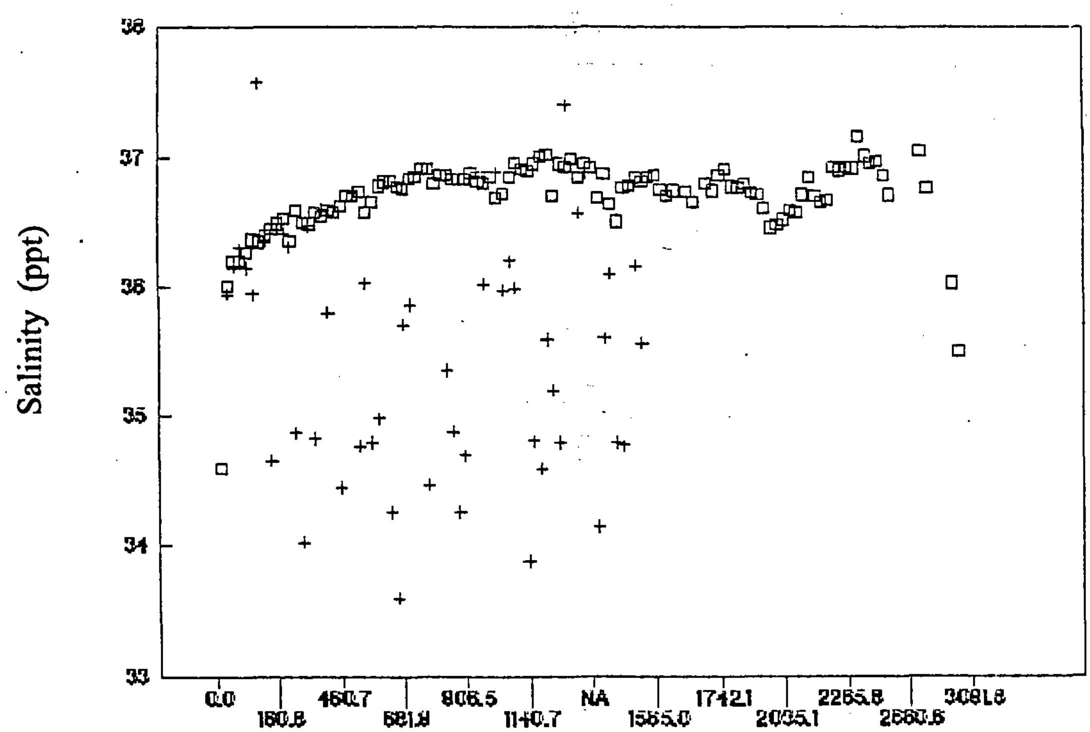


Figure 27

T-S plot of Surface Temperature (T_S) vs Surface Salinity (S_S) for first 3000 nm (to Antigua) of CC-115. In general the graph shows the expected trend of increasing salinity with increasing temperature as CC-115 approached and entered tropical surface water. The right half of the graph demonstrates the "partitioning" of the North Atlantic surface ocean across the Mid-Atlantic Ridge. The salinity peak near 37.0 ppt and associated with surface temperatures of 22-23 °C is the Sal Max Water found on the eastern side of the ridge. The ridge area itself is characterized by temperatures in the 25-25 °C range but salinities values below 36.7 ppt. On the far right of the graph, CC-115 enters the Sal Max pool of the Western NA where T_S are >25 °C and salinity values approach 37.2 ppt.

Graph by Busby, MacDonald, Cochrane and Kenna.

Figure 28

A Density-Temperature plot for surface data collected during first 3000 nm (to Antigua) of CC-115. Plot shows the expected negative correlation between density (in Sigma-θ) values and temperature.

B Density-Salinity plot for surface data collected during first 3000 nm (to Antigua) of CC-115. This plot shows an unexpected relationship - a strong negative correlation between density (in Sigma-θ) values and rising S_S. This relationship, in combination with that shown in Figure 28A clearly shows that, for the surface waters of our Trans-Atlantic crossing, temperature changes were more important that salinity changes in determining the density of sea water.

Graphs by Busby, MacDonald, Cochrane and Kenna.

Figure 27

T_S vs Average Bottle SS

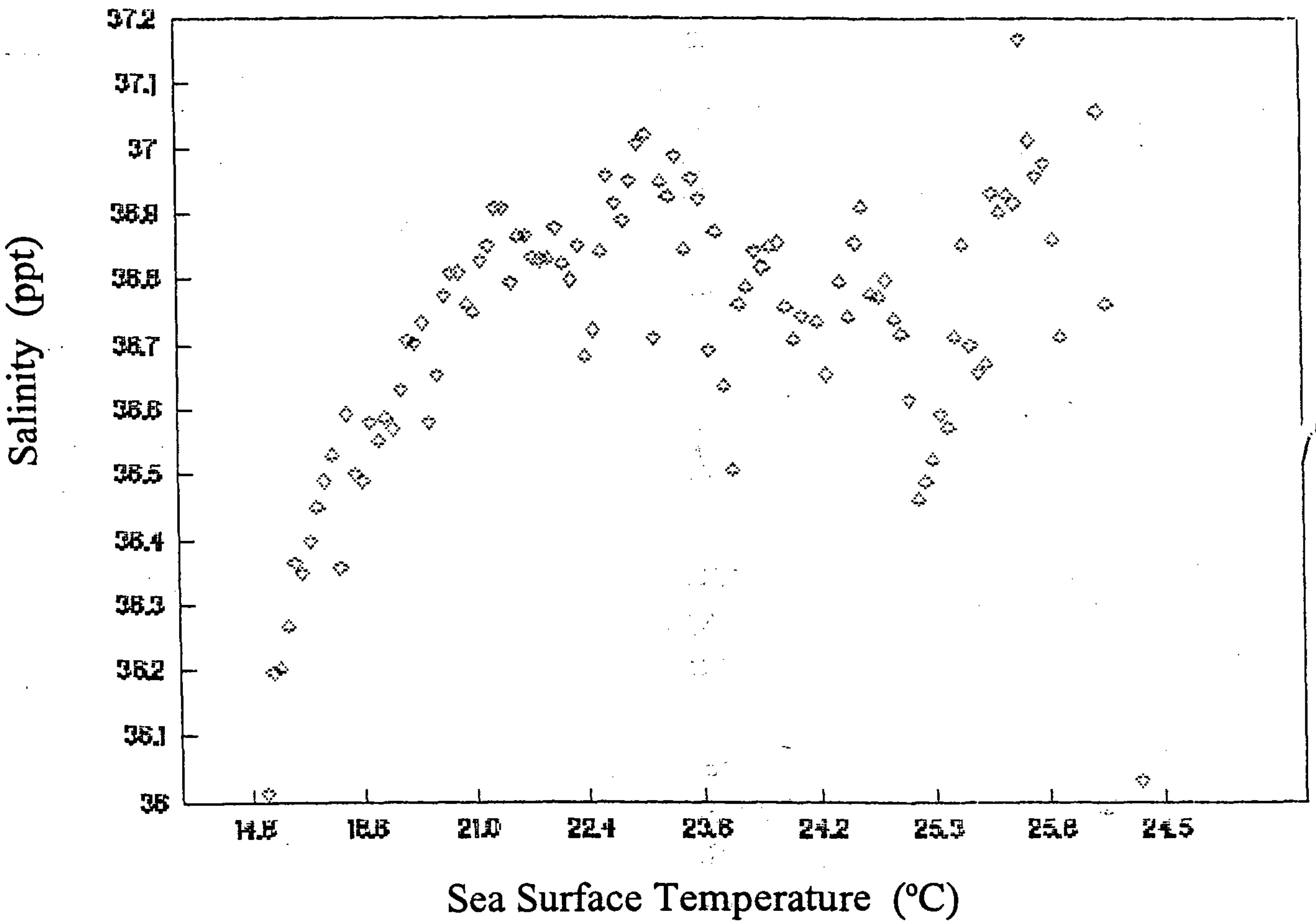


Figure 28A

Sigma-θ vs T_S

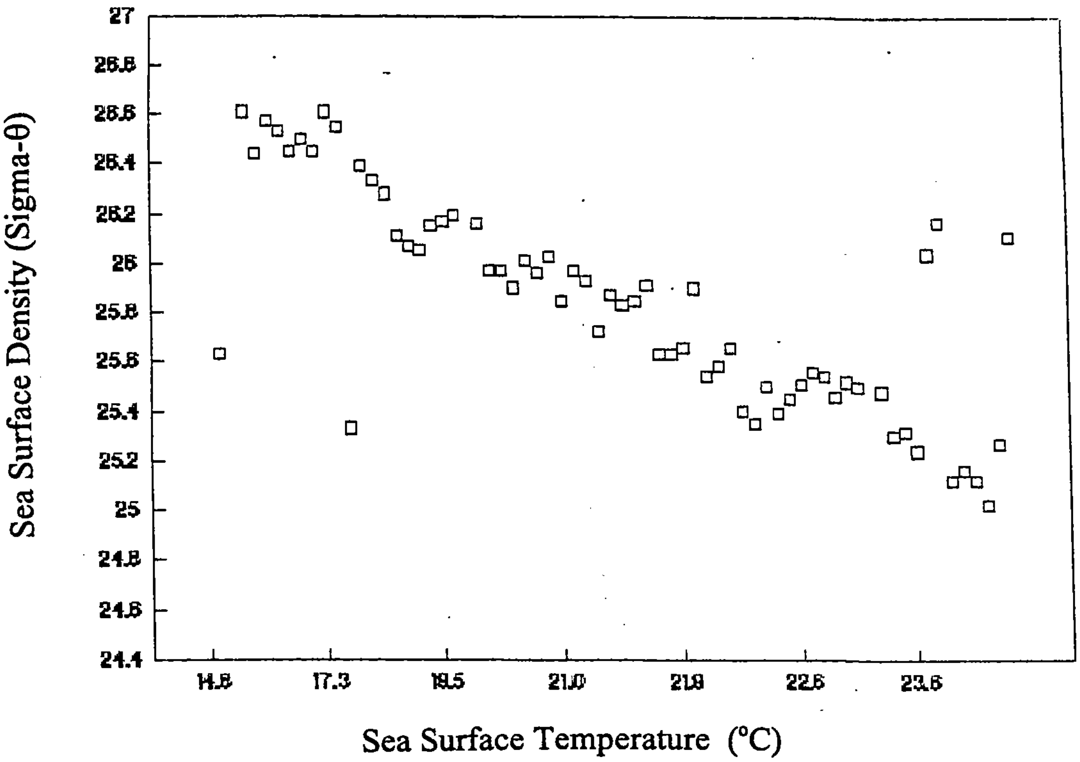


Figure 28B

Sigma-θ vs SS

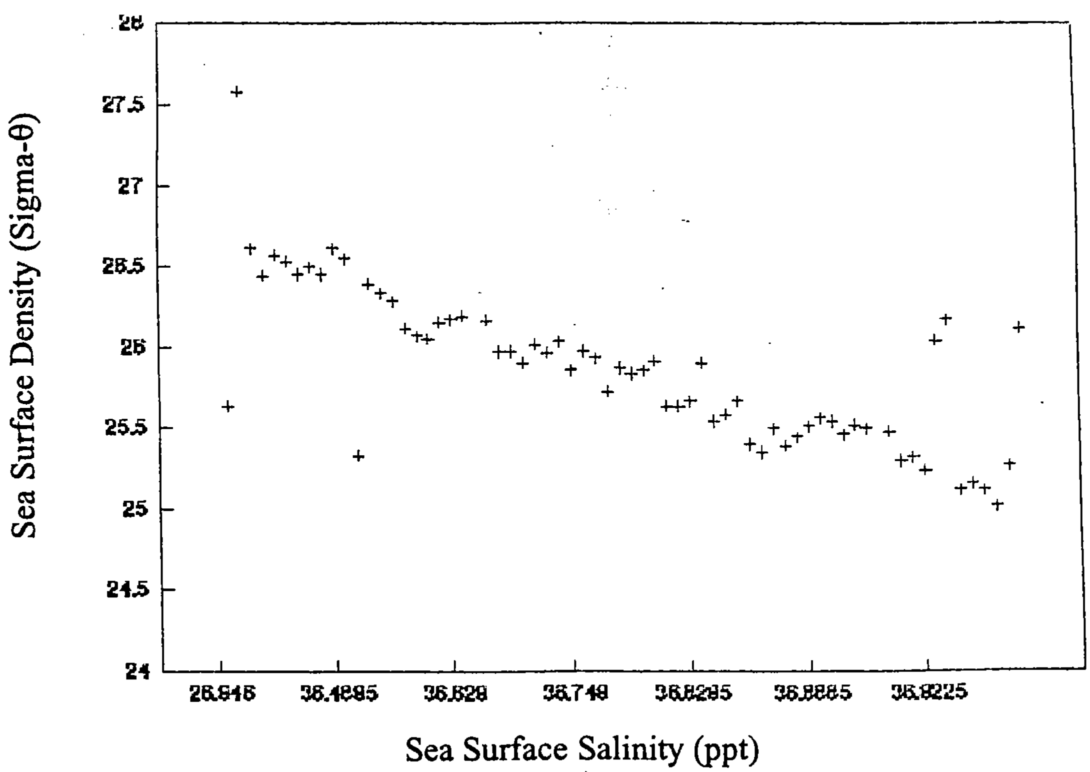


Figure 30

A Plot of salinity values measured at the "core depth" of Sal Max Water on trans-Atlantic transect. Sal Max values on the eastern side of the Mid-Atlantic Ridge are generally less than 37.0 ppt. Sal Max values on the western side of the ridge are significantly higher - all greater than 37.1 ppt.

B Plot of temperature values measured at the "core depth" of Sal Max Water on trans-Atlantic transect. Sal Max temperature values on the eastern side of the ridge are in the 23-25 °C range. On the western side of the ridge Sal Max temperature values are generally greater than 26 °C. These subsurface trends closely parallel those found for the surface pools of Sal Max Water on either side of the Ridge (see Figure 27). The higher salinity values found in the west are matched by significantly higher temperature values. This results in a trans-Atlantic Sal Max layer of variable T-S personality but one of equal density.

Graphs by Busby, MacDonald, Cochrane, and Kenna.

Figure 30A

Salinity Max Core vs Longitude

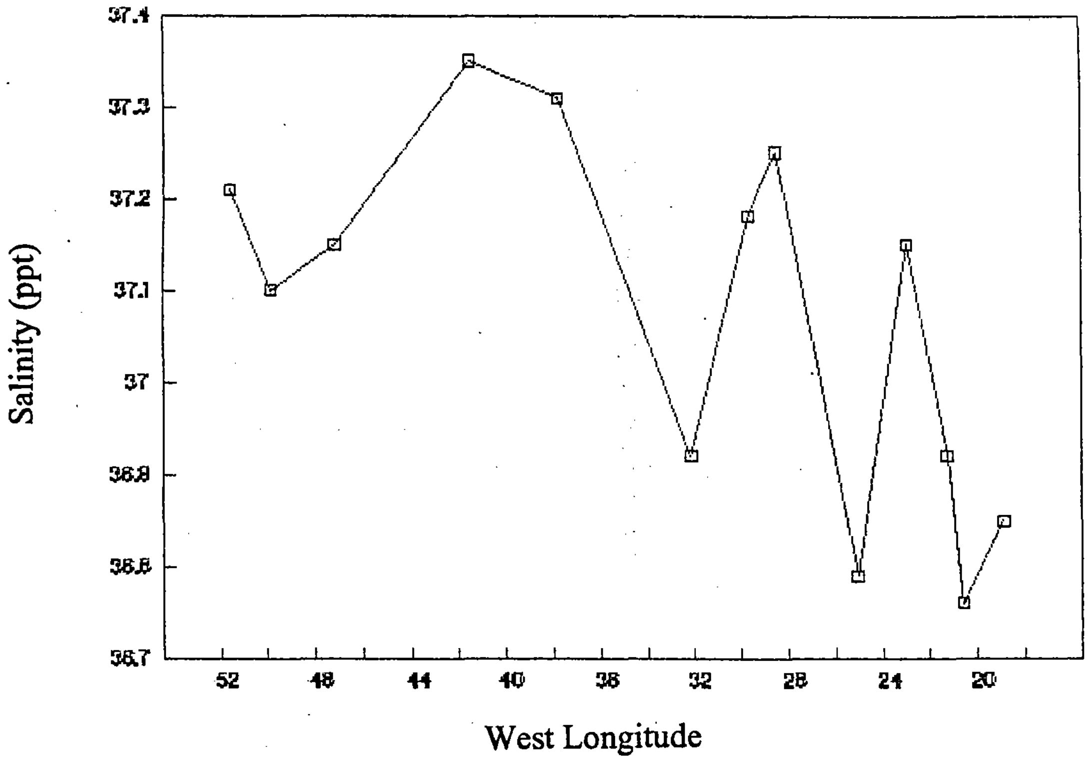


Figure 30B

Temperature at Salinity Max Core vs Longitude

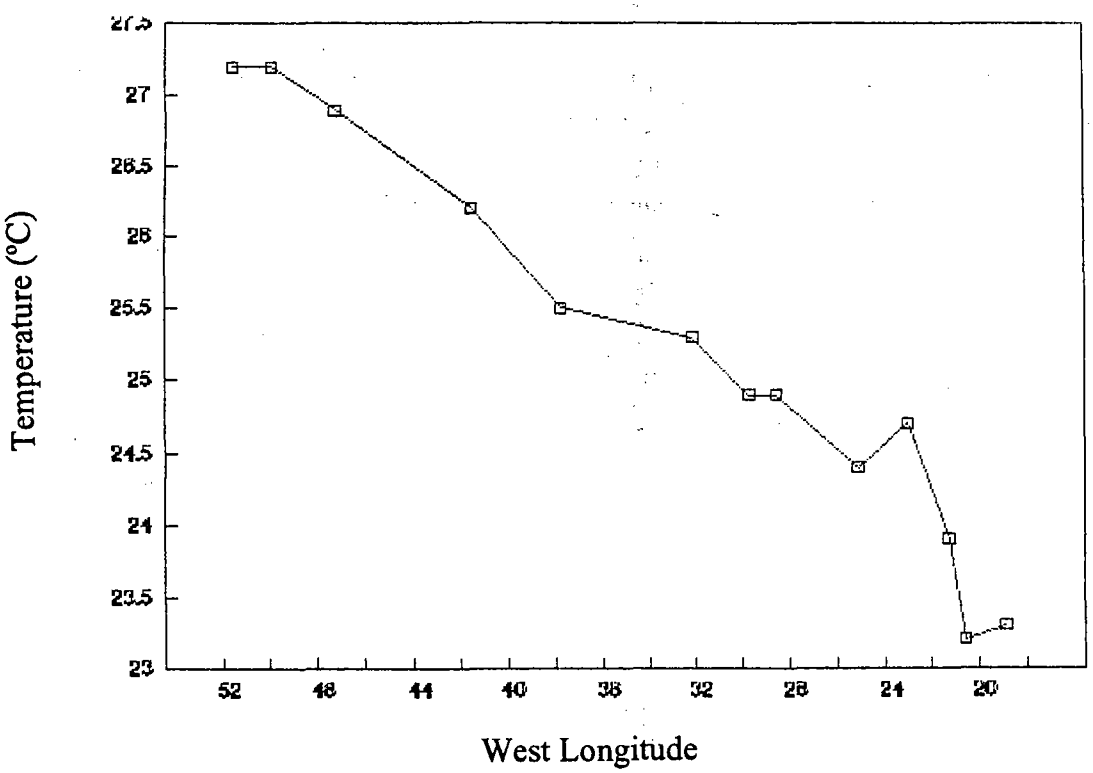


Figure 31

Pie diagrams of the dominant groups of organisms found in the first twelve neuston tows obtained on CC-115. "A" shows dominant organisms in the day tows; "B" shows the dominant organisms in the night tows. Major taxa are similar for both day and night tows. The filter-feeding, herbivorous copepods compose more than 50% of all night organisms while the predatory chaetognaths comprise a relatively high % of the day tows. Since the species present for both day and night tows were similar, the differences in relative importance of taxa is most likely the result of diel migration - particularly on the part of the herbivores. In general, zooplankton biomass was extremely low in all tows obtained on CC-115.

All data and graphs by Melendy, Scheirer, Cutler, Hotaling, Coler, Rand, Stone, Lyman and Kenna.

Figure 32

Plots of *Halobates* distribution on trans-Atlantic transect completed during CC-115. "A" shows data from the Net A replicate taken at each station; "B" is from second replicate. In both figures boxes indicate the number of adult *Halobates*, crosses the number of juvenile *Halobates* and diamonds the total number for each tow. In general, *Halobates* were rare or absent during the initial part of the cruise. However, once CC-115 reach the latitude of crossing (16 °N), *Halobates* were common and became more abundant to the west. In particular, the number of juvenile *Halobates* increased significantly in a westward direction.

All data and graphs by Melendy, Scheirer, Cutler, Hotaling, Coler, Rand, Stone, Lyman and Kenna

Figure 31A

Dominant Organism in Day Tows
Neuston Tows 1-12

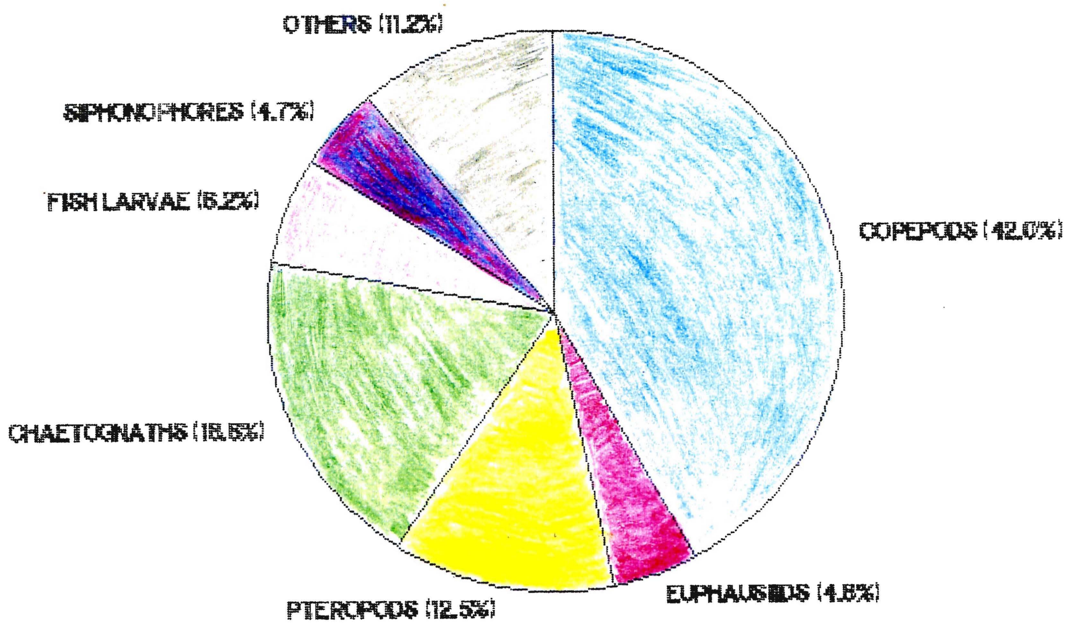


Figure 31B

Dominant Organism in Night Tows
Neuston Tows 1-12

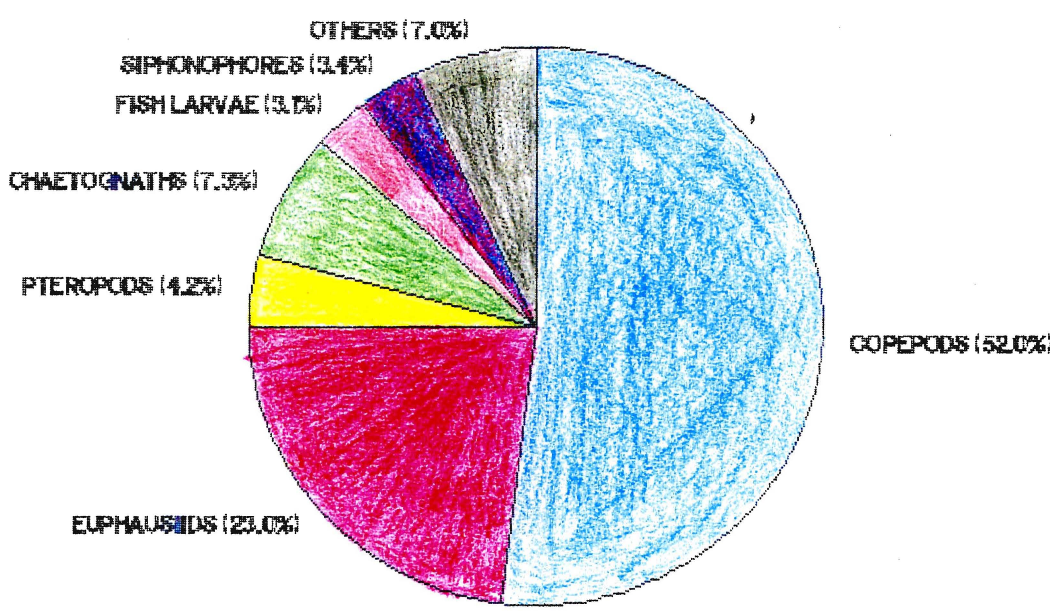


Figure 32A

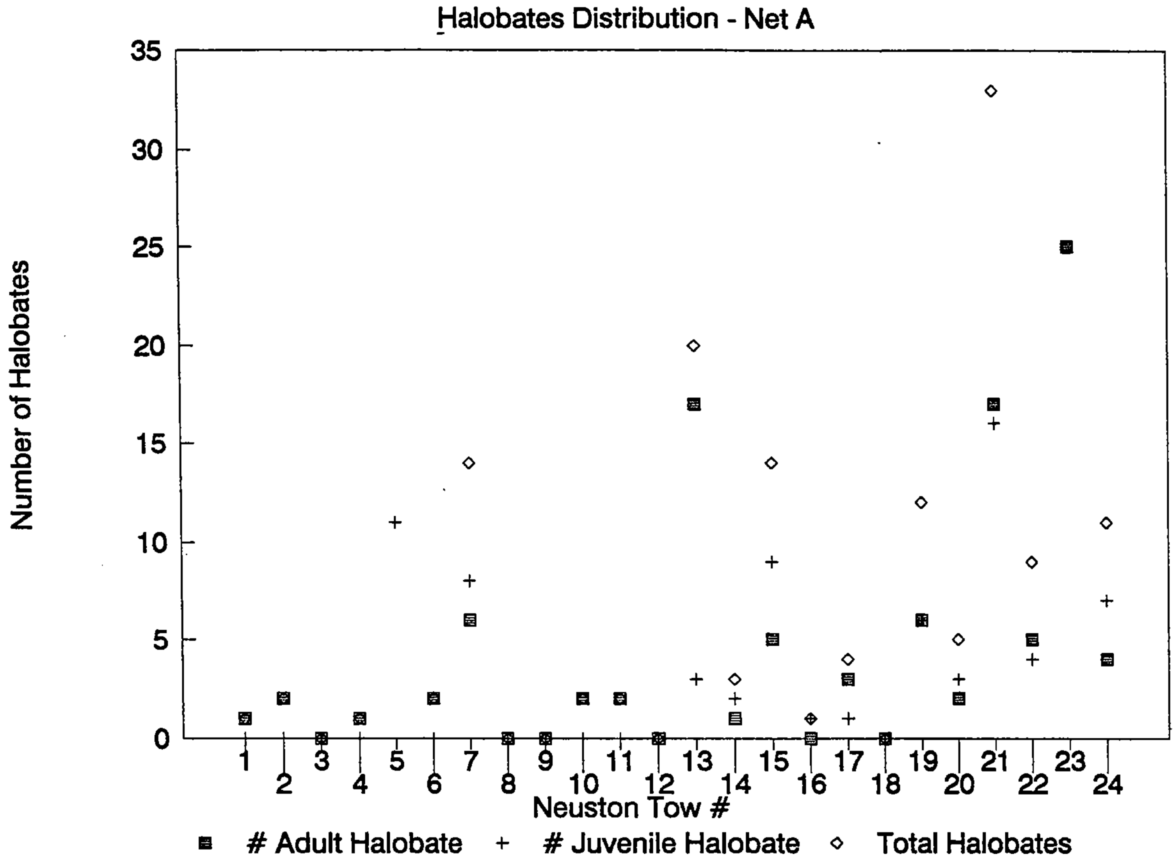


Figure 32B

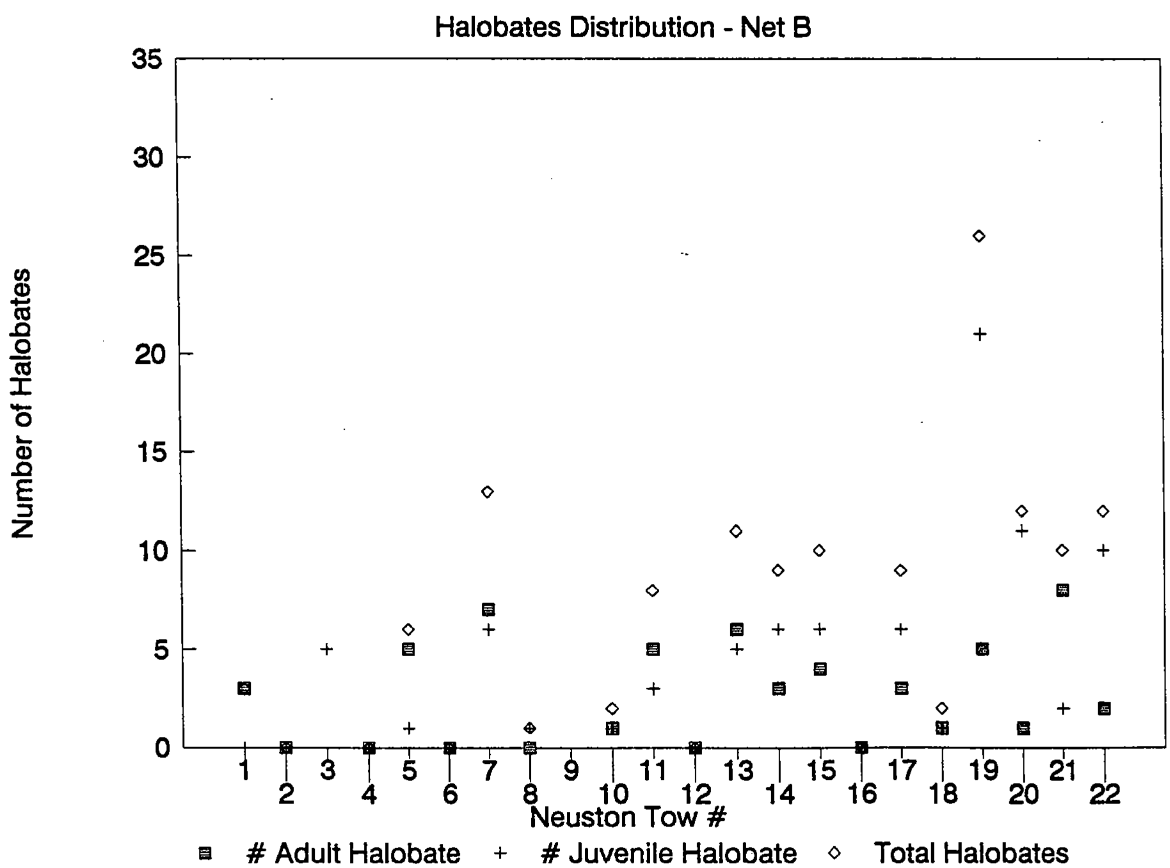


Figure 33

A Plot of Plastic Distribution on trans-Atlantic transect completed on CC-115. This graph shows the distribution of total plastic pieces (boxes) and polyethylene pellets (crosses) plotted against distance, as measured by the ship's log. The highest values obtained for plastic were all in the Eastern North Atlantic on the Lisbon-to-Canaries leg. In most cases the plastic obtained appeared fresh and may be attributed to recent input (dumping) from surface vessels in the heavily-traveled shipping lanes of the eastern Atlantic. Once CC-115 reached the latitude of crossing (16°N) plastic became rare or absent. This distribution was suspected based on the regional oceanic patterns previously determined by SEA vessels. This is the first data set which supports the earlier interpretation.

B Plot of Tarball Distribution on trans-Atlantic transect completed on CC-115. This graph shows the distribution of mean tarball density determined from replicate neuston tows. The highest values obtained for tar were all in the Eastern North Atlantic on the Lisbon-to-Canaries leg. In most cases the tar obtained appeared fresh and may be attributed to recent input (dumping) from surface vessels in the heavily-traveled shipping lanes of the eastern Atlantic. Once CC-115 reached the latitude of crossing (16°N) tar became rare. This distribution was suspected based on the regional oceanic patterns previously determined by SEA vessels. This is the first data set which supports the earlier interpretation.

All data and graphs by Kinney, Kaericher, Land and Lyman.

Figure 33A

Plastic Pieces and Pellets vs Log

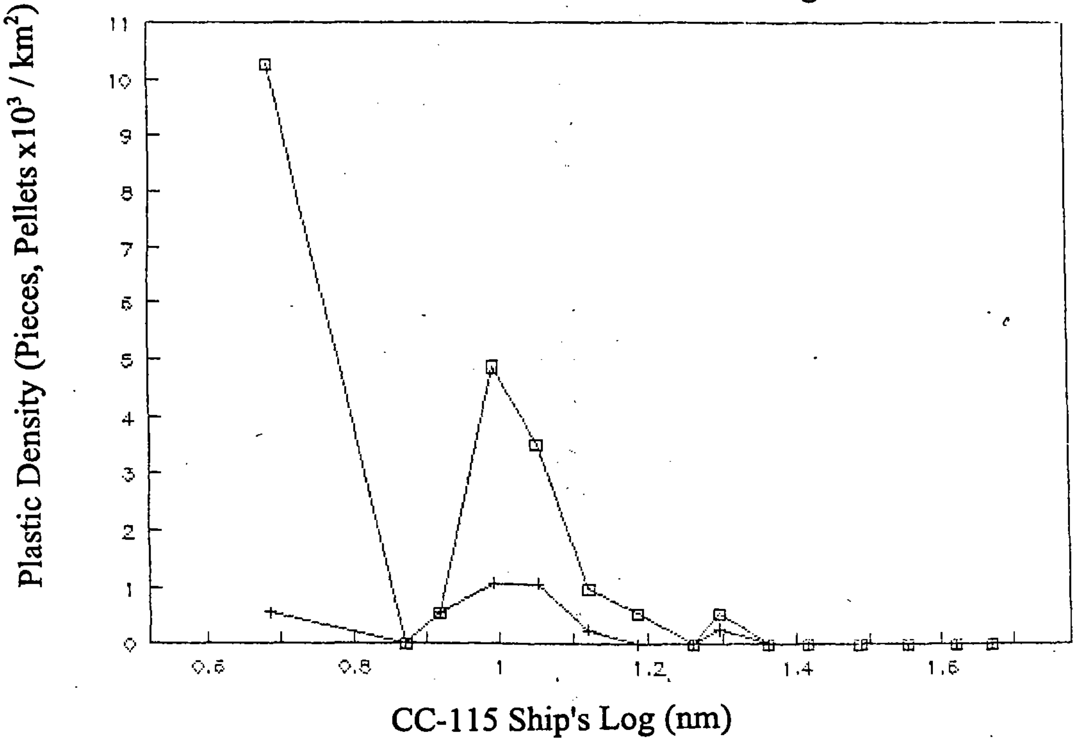
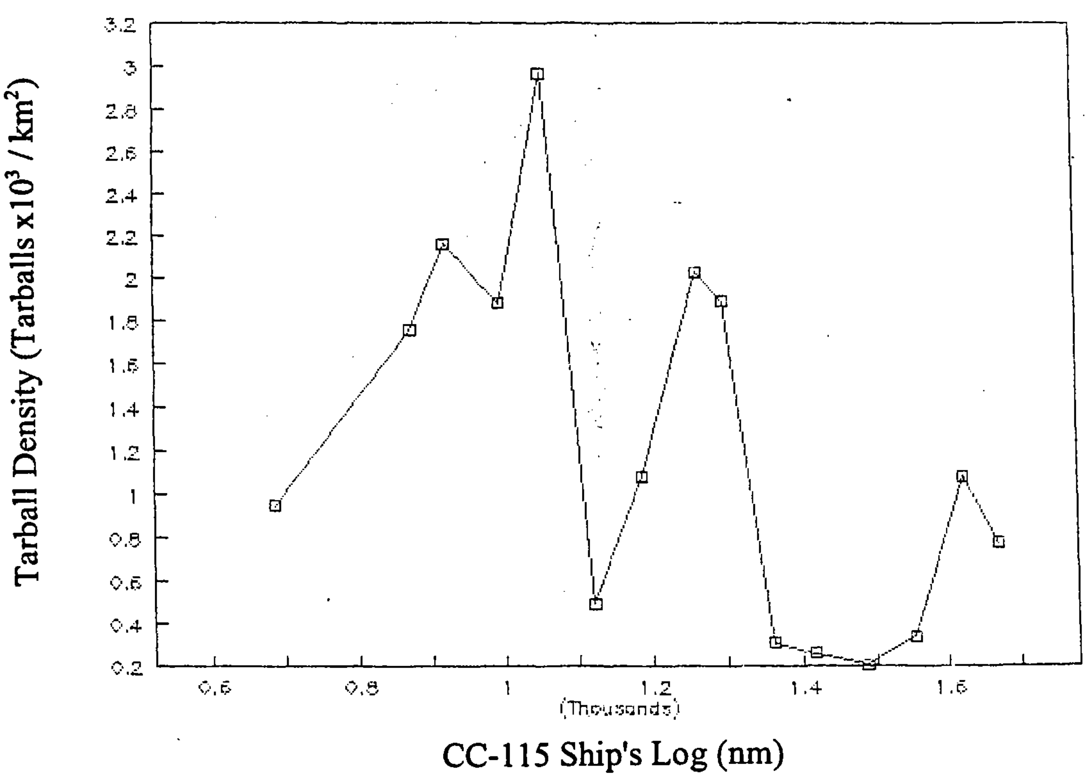


Figure 33B

Tarballs vs Log



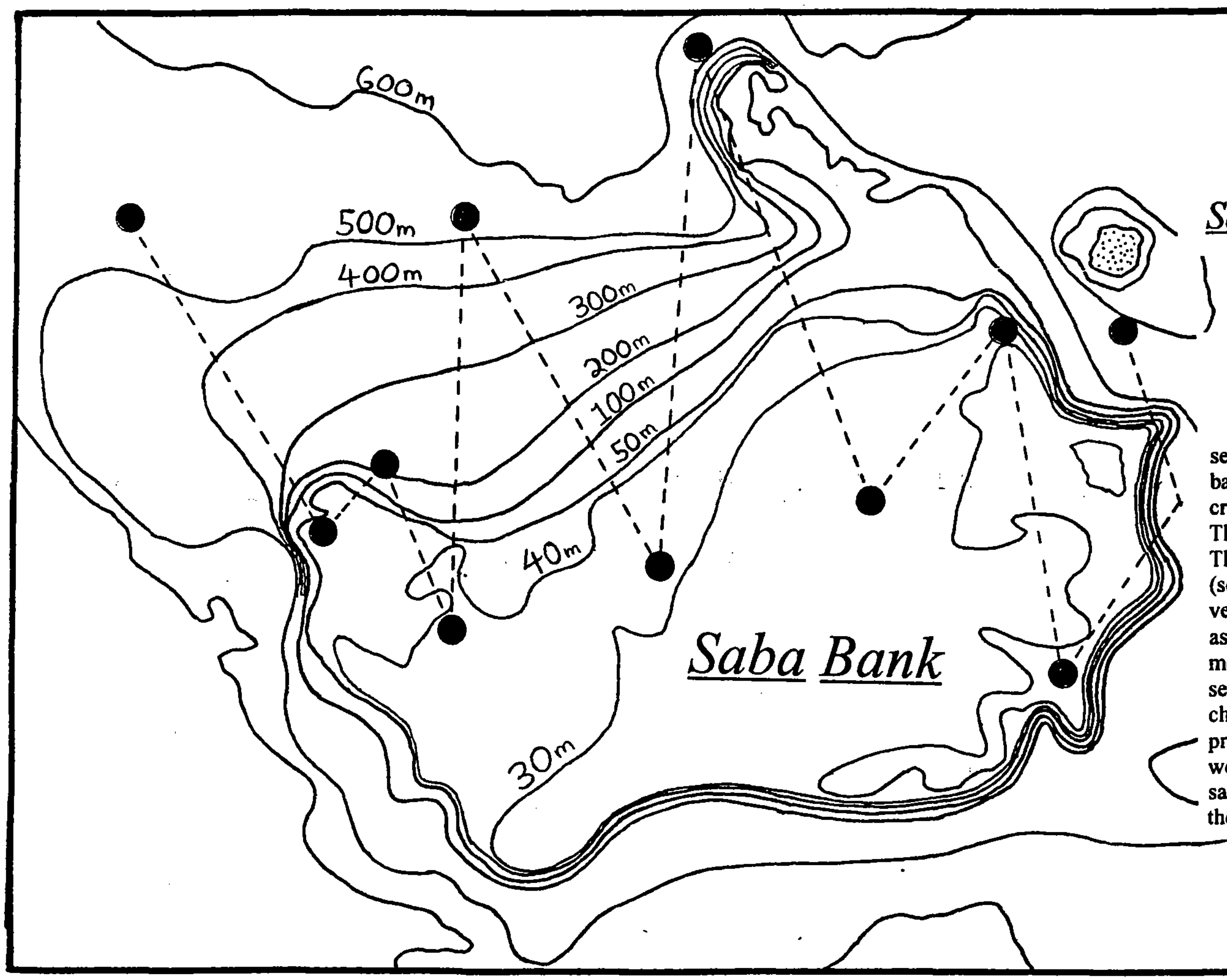


Figure 34

Bathymetric map of Saba Bank showing CC-115 seismic lines and sediment sample sites. Bathymetry is based on data collected during CC-115, other SEA cruises, and previously published bathymetric soundings. The bank-top of Saba is enclosed by the 50m isobath. The southern and eastern slope of Saba are precipitous (see Figure 35). In contrast, the northwestern slope is very gentle and extended resulting in a pronounced asymmetry to the platform (see Figure 36) This gross morphological asymmetry is reflected in the modern sediment distribution (Figure 37)and, over time, this characteristic of the bank has resulted from the same processes governing modern sediment transport. The work on Saba was accomplished completely under sail as we tacked back and forth - sailing hard against the NE Trade to maximize our seismic coverage.

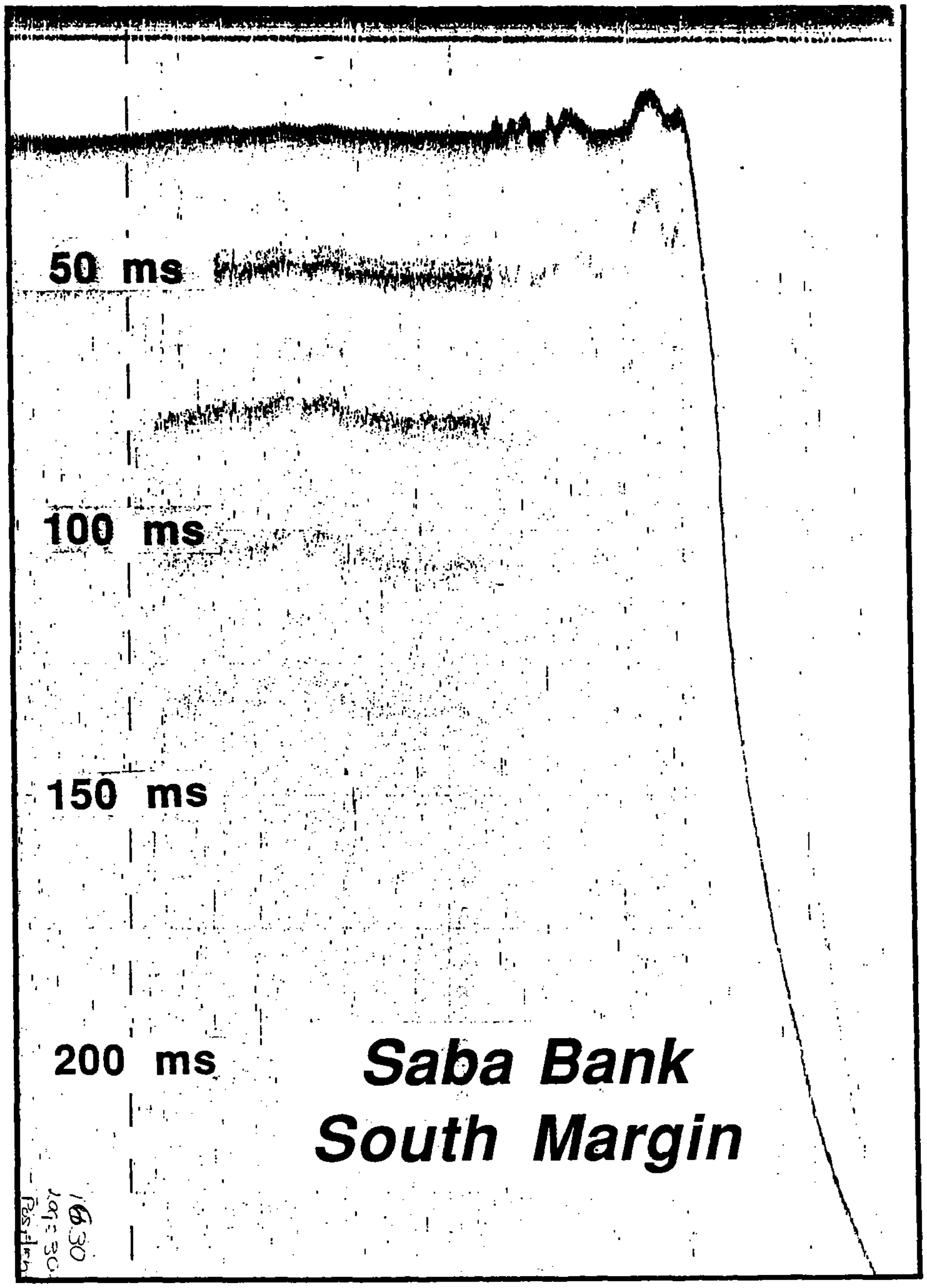


Figure 35

3.5 kHz seismic profile obtained on CC-115 across the southeastern margin of Saba Bank. The side of Saba is precipitous and sediment-free.

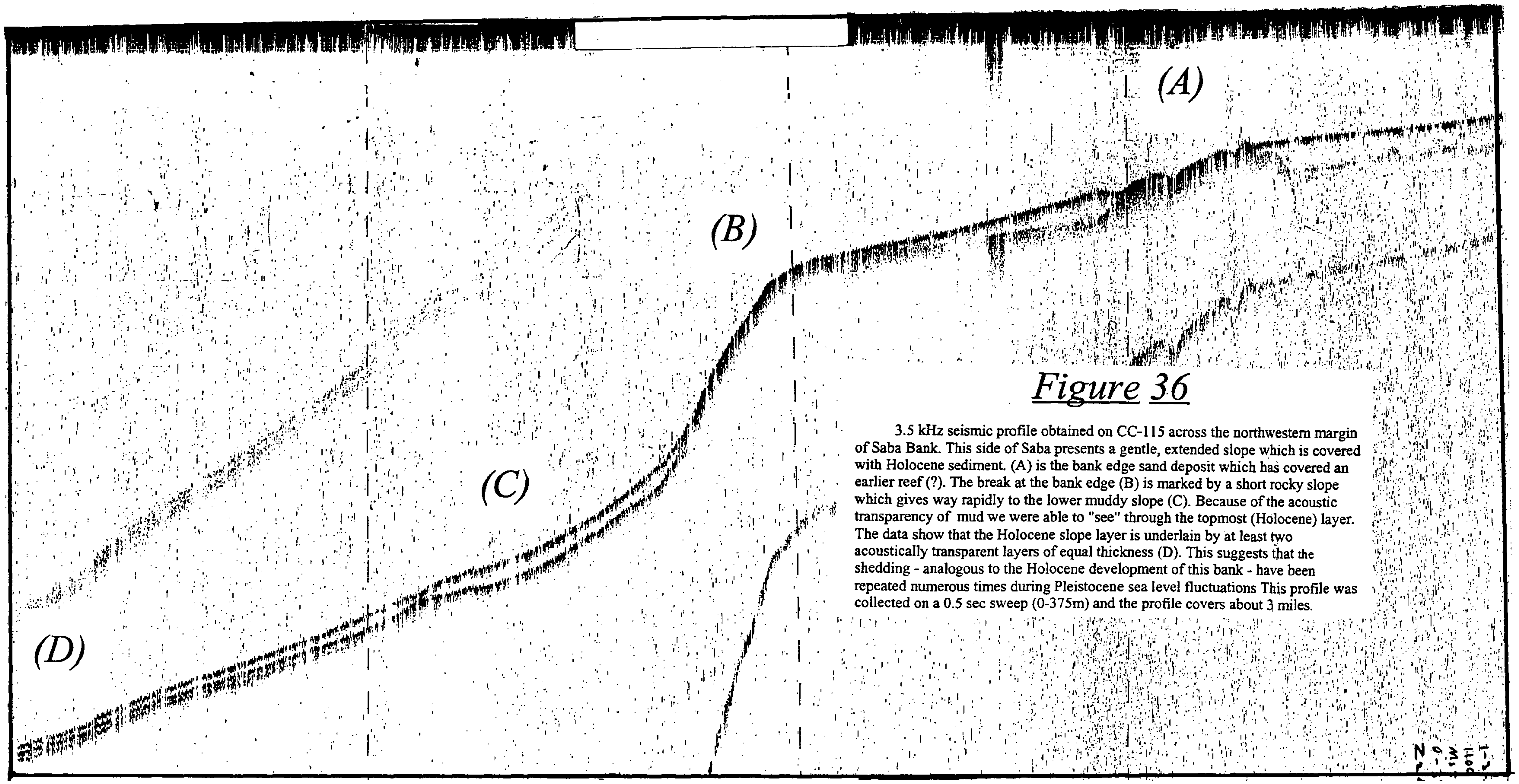


Figure 36

3.5 kHz seismic profile obtained on CC-115 across the northwestern margin of Saba Bank. This side of Saba presents a gentle, extended slope which is covered with Holocene sediment. (A) is the bank edge sand deposit which has covered an earlier reef (?). The break at the bank edge (B) is marked by a short rocky slope which gives way rapidly to the lower muddy slope (C). Because of the acoustic transparency of mud we were able to "see" through the topmost (Holocene) layer. The data show that the Holocene slope layer is underlain by at least two acoustically transparent layers of equal thickness (D). This suggests that the shedding - analogous to the Holocene development of this bank - have been repeated numerous times during Pleistocene sea level fluctuations This profile was collected on a 0.5 sec sweep (0-375m) and the profile covers about 3 miles.

Figure 37

Isopach map of Holocene sediment thickness along the northwestern margin of Saba Bank. The bank edge deposits are primarily sand whereas the slope deposits are rich in mud. It is this asymmetric deposition of sediment which, over time, has resulted in the gross asymmetric bank morphology so clearly seen at Saba.

Figure 38

Plot of mud % in bottom sediment across the northwestern margin of Saba Bank. These data reveal the major differences between the bank-edge sands and upper-slope muds. The "mud max" which occurs on the upper slope is coincidentally (?) located at the same depth as the Sal Max layer.

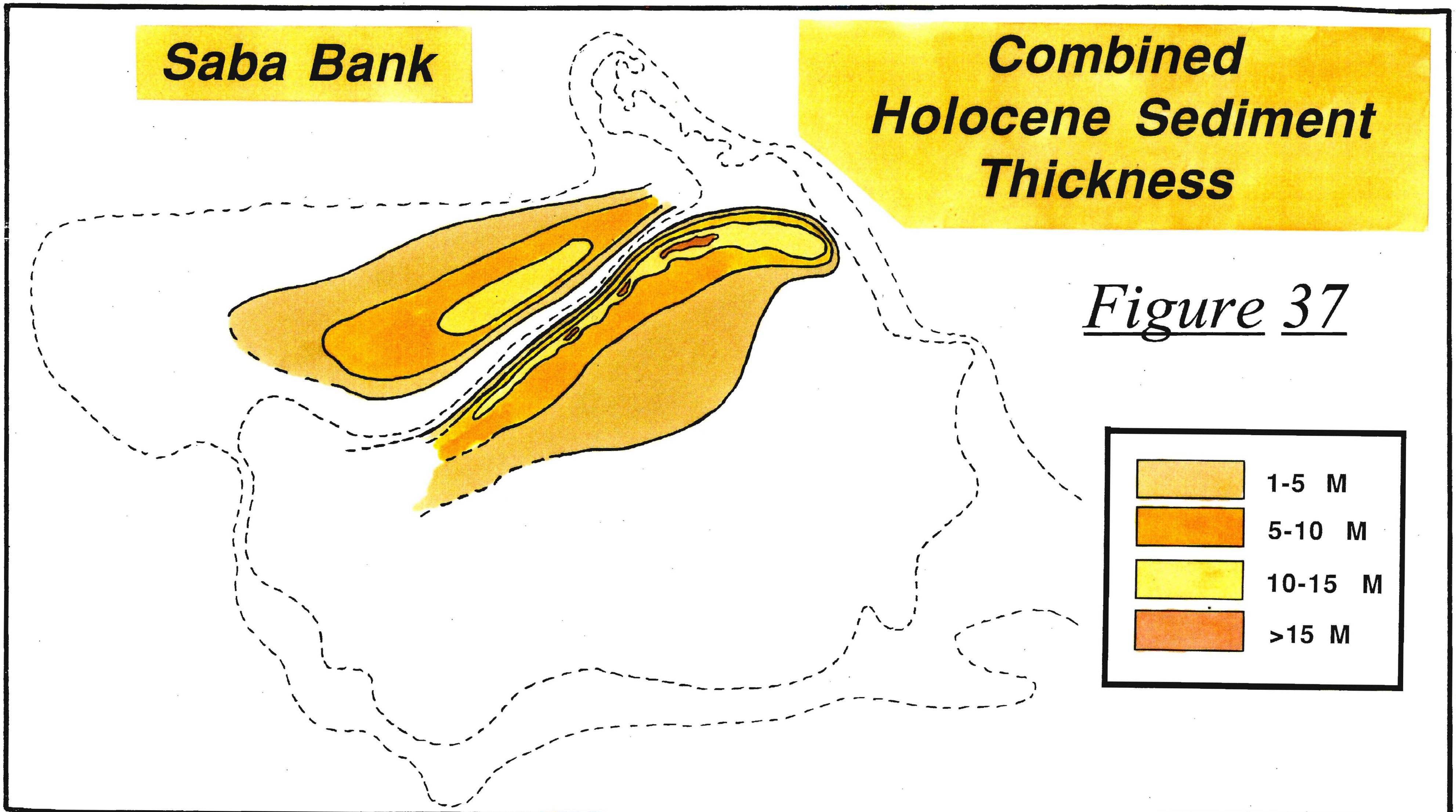
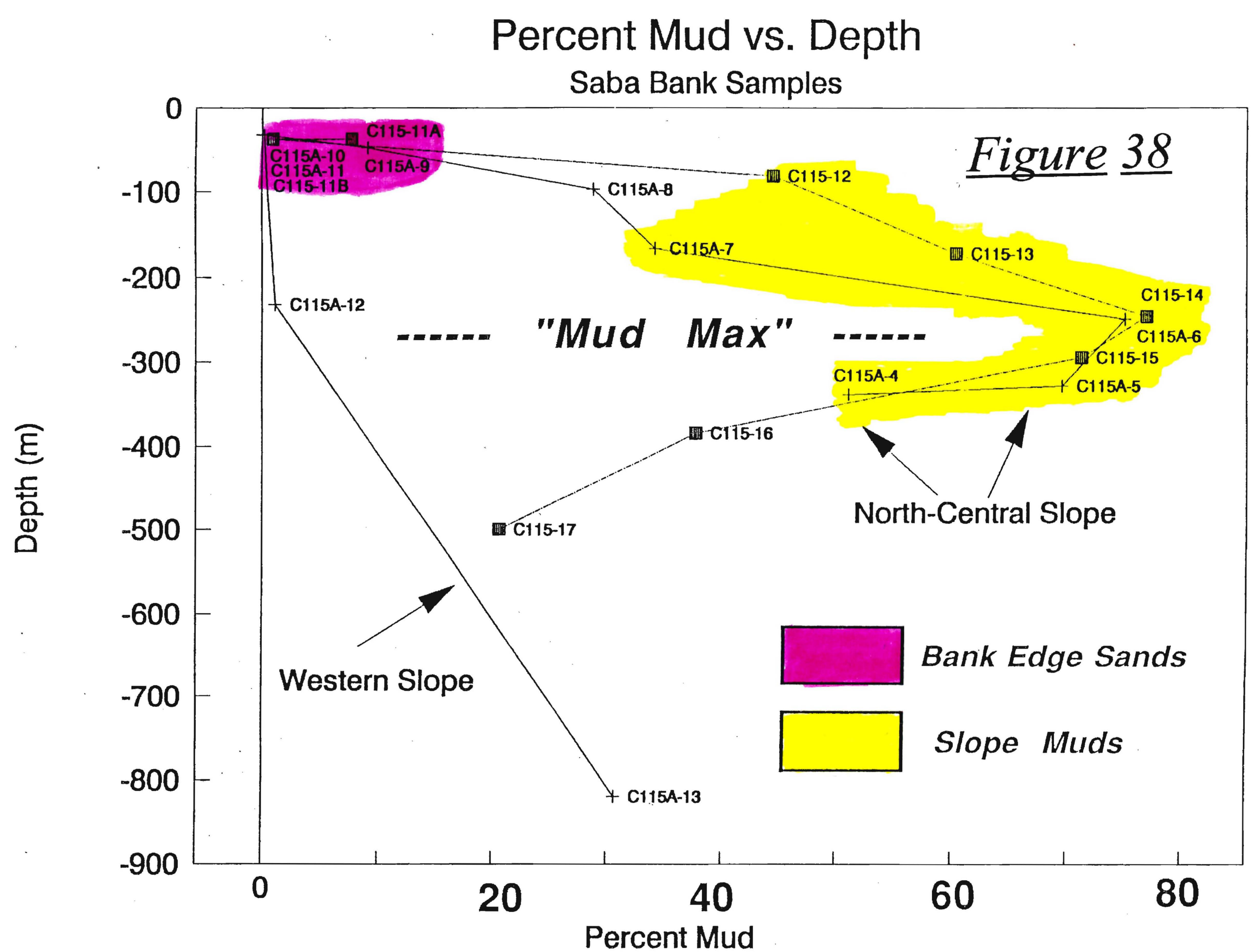

Saba Bank
Combined
Holocene Sediment
Thickness
1-5 M
5-10 M
10-15 M
>15 M

Figure 37


Percent Mud vs. Depth
Saba Bank Samples
Figure 38
Depth (m)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
0
20
40
60
80
Percent Mud
C115-11A
C115A-10
C115A-11
C115-11B
C115A-9
C115-12
C115A-8
C115A-7
C115-13
C115-14
C115A-6
C115-15
C115A-5
C115A-4
C115-16
C115-17
C115A-12
C115A-13
"Mud Max"
North-Central Slope
Western Slope
Bank Edge Sands
Slope Muds

CC-115 Data Appendices

Including:

Appendix A - Surface Trends Data
Appendix B - Neuston Data
Appendix C - MBT Data
Appendix D - CTD Data

Appendix A
CC-115 Surface Trends Data

DAY	DATE	TIME	LOG	CRUISE HOUR	PRESSURE	BF	SEA TEMP	AIR TEMP
Wed	112890	1600	0.0	1	1016.0	2.0	14.8	15.0
Wed	112890	1700	0.6	2	1016.5	2.0	14.8	13.8
Wed	112890	1800	5.0	3	1016.6	2.0	15.3	13.5
Wed	112890	1900	9.5	4	1016.3	3.0	15.9	13.5
Wed	112890	2000	12.0	5	1017.3	1.5	16.4	13.7
Wed	112890	2100	20.5	6	1017.7	1.5	16.4	13.6
Wed	112890	2200	28.5	7	1018.2	1.5	16.9	14.0
Wed	112890	2300	38.1	8	1018.2	1.5	17.3	14.0
Thu	112990	0000	45.3	9	1018.1	1.5	17.1	14.0
Thu	112990	0100	55.5	10	1017.7	1.5	17.2	14.0
Thu	112990	0200	63.9	11	1017.6	1.5	16.8	13.9
Thu	112990	0300	72.6	12	1017.7	2.5	17.5	14.0
Thu	112990	0400	81.4	13	1017.9	0.0	17.3	14.1
Thu	112990	0500	89.8	14	1017.6	0.0	17.2	13.7
Thu	112990	0600	98.7	15	1017.7	0.0	17.6	14.0
Thu	112990	0700	107.5	16	1017.7	1.0	17.2	14.5
Thu	112990	0800	116.3	17	1017.9	1.0	17.6	15.0
Thu	112990	0900	123.9	18	1018.0	1.0	17.5	15.9
Thu	112990	1000	130.1	19	1018.0	1.0	17.8	17.0
Thu	112990	1100	131.4	20	1018.1	1.5	17.7	16.7
Thu	112990	1200	135.3	21	1017.4	2.0	17.2	17.0
Thu	112990	1300	144.0	22	1016.2	1.0	17.8	17.2
Thu	112990	1400	151.3	23	1015.8	2.0	17.7	17.2
Thu	112990	1500	NA	24	NA	2.0	NA	NA
Thu	112990	1600	160.8	25	NA	3.0	NA	NA
Thu	112990	1700	160.8	26	1015.5	4.0	17.3	17.0
Thu	112990	1800	160.8	27	NA	4.0	17.5	17.3
Thu	112990	1900	164.7	28	1014.9	5.0	17.5	17.0
Thu	112990	2000	171.5	29	1014.9	5.0	17.8	17.5
Thu	112990	2100	178.4	30	1014.4	5.0	17.7	17.4
Thu	112990	2200	185.0	31	1014.4	4.0	17.7	17.7
Thu	112990	2300	192.5	32	1014.2	5.0	17.6	17.9
Fri	113090	0000	198.1	33	1013.2	5.0	17.5	18.0
Fri	113090	0100	204.4	34	1012.2	5.5	18.0	17.5
Fri	113090	0200	207.8	35	1011.6	5.5	18.1	17.5
Fri	113090	0300	209.0	36	1011.0	5.5	18.1	17.6
Fri	113090	0400	210.3	37	1011.0	6.0	17.8	17.2
Fri	113090	0500	211.8	38	1010.8	6.0	18.1	18.0
Fri	113090	0600	214.7	39	1010.0	6.0	18.2	17.0
Fri	113090	0700	215.0	40	1009.0	6.0	18.1	17.5
Fri	113090	0800	217.7	41	1009.1	6.0	18.2	17.7
Fri	113090	0900	218.8	42	1009.5	6.0	18.2	18.5
Fri	113090	1000	219.9	43	1009.7	7.0	18.5	19.0
Fri	113090	1100	221.3	44	1010.1	6.0	18.6	18.9
Fri	113090	1200	222.9	45	1009.6	6.0	18.6	18.8
Fri	113090	1300	224.1	46	1007.9	7.0	18.5	18.3
Fri	113090	1400	226.4	47	1007.4	7.5	18.8	18.0
Fri	113090	1500	228.9	48	1006.9	7.5	18.7	18.0
Fri	113090	1600	229.2	49	1007.2	7.5	18.9	18.0
Fri	113090	1700	230.9	50	1007.0	8.5	19.0	18.2
Fri	113090	1800	232.7	51	1007.5	8.5	18.9	18.0
Fri	113090	1900	234.4	52	1008.2	7.5	18.8	18.5
Fri	113090	2000	236.3	53	1008.4	7.5	NA	16.3
Fri	113090	2100	237.4	54	1008.5	7.5	18.5	18.5

DAY	DATE	TIME	LOG	CRUISE HOUR	PRESSURE	BF	SEA TEMP	AIR TEMP
Fri	113090	2200	239.3	55	1008.0	7.5	18.5	18.5
Fri	113090	2300	240.7	56	1008.0	7.5	18.5	18.8
Sat	120190	0000	242.5	57	1008.1	7.5	18.7	18.9
Sat	120190	0100	243.5	58	1008.2	7.5	18.6	18.9
Sat	120190	0200	245.0	59	1008.1	7.5	18.7	18.8
Sat	120190	0300	246.4	60	1007.5	7.5	18.5	18.8
Sat	120190	0400	247.7	61	1007.8	7.5	18.5	18.9
Sat	120190	0500	252.0	62	1008.3	7.5	18.5	19.0
Sat	120190	0600	257.0	63	1008.5	7.5	18.8	19.2
Sat	120190	0700	262.4	64	1008.3	8.0	18.8	19.2
Sat	120190	0800	269.9	65	1008.5	6.0	18.6	19.0
Sat	120190	0900	275.5	66	1009.0	6.0	18.7	19.1
Sat	120190	1000	282.3	67	1008.5	7.0	NA	NA
Sat	120190	1100	289.2	68	NA	7.0	NA	NA
Sat	120190	1200	296.2	69	NA	7.0	NA	NA
Sat	120190	1300	303.4	70	1005.2	7.0	NA	18.5
Sat	120190	1400	310.5	71	1004.2	7.0	NA	NA
Sat	120190	1500	317.3	72	1004.4	7.0	NA	NA
Sat	120190	1600	323.7	73	1004.4	7.0	NA	NA
Sat	120190	1700	330.2	74	1004.0	8.0	NA	NA
Sat	120190	1800	335.2	75	1005.1	8.0	NA	NA
Sat	120190	1900	340.0	76	1005.1	8.0	NA	NA
Sat	120190	2000	344.4	77	NA	7.5	NA	NA
Sat	120190	2100	349.5	78	1005.5	7.5	NA	NA
Sat	120190	2200	354.7	79	1004.5	7.0	NA	NA
Sat	120190	2300	358.6	80	1004.9	7.0	NA	NA
Sun	120290	0000	362.1	81	1004.5	4.0	19.4	19.0
Sun	120290	0100	NA	82	NA	4.0	NA	NA
Sun	120290	0200	366.2	83	1004.0	4.0	19.4	19.1
Sun	120290	0300	369.8	84	1004.0	4.0	NA	19.6
Sun	120290	0400	374.0	85	1004.3	4.5	19.6	19.4
Sun	120290	0500	377.5	86	1004.1	4.0	19.5	19.2
Sun	120290	0600	383.0	87	1003.6	4.0	19.6	19.8
Sun	120290	0700	387.7	88	1003.9	4.0	19.6	19.9
Sun	120290	0800	393.4	89	1003.8	4.0	NA	19.8
Sun	120290	0900	396.7	90	1004.4	4.0	19.6	NA
Sun	120290	1000	NA	91	1004.7	4.0	19.6	18.5
Sun	120290	1100	NA	92	NA	4.0	NA	NA
Sun	120290	1200	NA	93	1004.0	4.0	19.7	19.8
Sun	120290	1300	403.2	94	1003.4	4.0	19.9	19.8
Sun	120290	1400	NA	95	1003.1	4.0	19.6	NA
Sun	120290	1500	NA	96	NA	NA	NA	NA
Sun	120290	1600	NA	97	NA	4.0	NA	NA
Sun	120290	1700	405.7	98	NA	3.0	NA	NA
Sun	120290	1800	409.9	99	1003.7	3.0	19.7	19.5
Sun	120290	1900	414.7	100	1004.4	3.0	19.9	19.5
Sun	120290	2000	418.7	101	1004.9	3.0	19.8	19.7
Sun	120290	2100	423.2	102	1004.9	3.0	19.8	19.4
Sun	120290	2200	427.1	103	1004.9	3.0	19.4	19.4
Sun	120290	2300	433.1	104	1005.0	3.0	19.5	19.5
Mon	120390	0000	438.2	105	1004.4	4.0	19.3	19.8
Mon	120390	0100	443.3	106	1003.5	4.0	19.4	19.6
Mon	120390	0200	447.6	107	1002.5	5.5	19.4	19.4
Mon	120390	0300	449.1	108	1002.7	5.5	19.4	18.4

DAY	DATE	TIME	LOG	CRUISE HOUR	PRESSURE	BF	SEA TEMP	AIR TEMP
Wed	120590	1000	NA	163	1017.2 NA	1.0	NA	NA
Wed	120590	1100	NA	164	1017.2 NA	1.0	NA	NA
Wed	120590	1200	NA	165	1017.0 NA	1.0	NA	NA
Wed	120590	1300	NA	166	1016.2 NA	1.0	NA	NA
Wed	120590	1400	NA	167	NA	NA	NA	NA
Wed	120590	1500	NA	168	1016.1 NA	1.0	NA	NA
Wed	120590	1600	NA	169	1016.5 NA	1.0	NA	NA
Wed	120590	1700	NA	170	1016.5 NA	1.0	NA	NA
Wed	120590	1800	NA	171	1016.5 NA	1.0	NA	NA
Wed	120590	1900	NA	172	1016.5 NA	1.0	NA	NA
Wed	120590	2000	NA	173	1017.0 NA	1.0	NA	NA
Wed	120590	2100	NA	174	1017.5 NA	1.0	NA	NA
Wed	120590	2200	NA	175	1017.8 NA	1.0	NA	NA
Wed	120590	2300	NA	176	1017.5 NA	1.0	NA	NA
Th	120690	0000	NA	177	1017.4 NA	0.0	NA	NA
Th	120690	0100	NA	178	1017.2 NA	0.0	NA	NA
Th	120690	0200	NA	179	1017.3 NA	0.0	NA	NA
Th	120690	0300	NA	180	1017.2 NA	0.0	NA	NA
Th	120690	0400	NA	181	1017.4 NA	0.0	NA	NA
Th	120690	0500	NA	182	1017.1 NA	0.0	NA	NA
Th	120690	0600	NA	183	1017.1 NA	0.0	NA	NA
Th	120690	0700	NA	184	1017.5 NA	0.0	NA	NA
Th	120690	0800	NA	185	1017.7 NA	0.0	NA	NA
Th	120690	0900	NA	186	1018.0 NA	0.0	NA	NA
Th	120690	1000	NA	187	1018.2 NA	1.0	NA	NA
Th	120690	1100	NA	188	1018.0 NA	1.0	NA	NA
Th	120690	1200	NA	189	NA	NA	NA	NA
Th	120690	1300	NA	190	1017.8 NA	1.0	NA	NA
Th	120690	1400	NA	191	1017.5 NA	1.0	NA	NA
Th	120690	1500	NA	192	1017.4 NA	1.0	NA	NA
Th	120690	1600	NA	193	1017.2 NA	1.0	NA	NA
Th	120690	1700	NA	194	1017.2 NA	1.0	NA	NA
Th	120690	1800	NA	195	1017.2 NA	1.0	NA	NA
Th	120690	1900	NA	196	1017.2 NA	1.0	NA	NA
Th	120690	2000	NA	197	1017.7 NA	0.5	NA	NA
Th	120690	2100	588.6	198	1017.8	0.5	19.9	19.1
Th	120690	2200	596.6	199	1018.0	0.0	20.0	19.3
Th	120690	2300	602.5	200	1018.0	0.5	19.9	19.5
Fr	120790	0000	609.0	201	1017.0	NA	20.3	19.2
Fr	120790	0100	615.8	202	1017.0	1.0	20.5	19.2
Fr	120790	0200	620.8	203	1016.8	1.0	20.9	19.7
Fr	120790	0300	628.8	204	1016.6	1.0	20.6	19.5
Fr	120790	0400	629.9	205	1016.2	0.5	20.9	19.9
Fr	120790	0500	629.9	206	1016.2	0.5	20.8	19.6
Fr	120790	0600	636.1	207	1016.6	0.5	20.8	19.8
Fr	120790	0700	642.3	208	1016.0	0.5	20.8	19.7
Fr	120790	0800	649.3	209	1015.5	0.5	20.8	19.9
Fr	120790	0900	657.0	210	1017.6	1.0	20.9	21.0
Fr	120790	1000	663.3	211	1017.6	0.5	20.9	21.1
Fr	120790	1100	663.3	212	1018.1	0.5	20.9	20.3
Fr	120790	1200	664.7	213	1017.0	0.5	20.9	20.0
Fr	120790	1300	671.0	214	1016.3	0.5	20.7	21.4
Fr	120790	1400	678.0	215	1015.6	1.5	20.8	21.8
Fr	120790	1500	681.9	216	1014.2	2.0	21.0	20.9

DAY	DATE	TIME	LOG	CRUISE HOUR	PRESSURE	BF	SEA TEMP	AIR TEMP
Fr	120790	1600	684.8	217	1014.4	2.5	21.0	20.7
Fr	120790	1700	688.4	218	1014.9	2.0	20.8	20.9
Fr	120790	1800	688.4	219	1014.5	2.5	20.8	21.2
Fr	120790	1900	688.4	220	1015.0	2.5	20.8	21.2
Fr	120790	2000	694.8	221	1015.4	2.0	20.9	20.9
Fr	120790	2100	700.3	222	1015.4	2.0	20.8	20.8
Fr	120790	2200	708.4	223	1015.3	2.0	21.2	20.9
Fr	120790	2300	712.8	224	1014.8	2.0	20.9	20.8
Sa	120890	0000	718.8	225	1014.5	2.0	NA	20.9
Sa	120890	0100	722.0	226	1014.3	2.0	21.0	21.0
Sa	120890	0200	722.0	227	1014.0	2.0	21.0	21.0
Sa	120890	0300	723.8	228	1014.5	2.0	21.1	21.1
Sa	120890	0400	721.3	229	1013.0	2.0	21.2	21.3
Sa	120890	0500	731.3	230	1013.0	2.0	21.2	21.5
Sa	120890	0600	735.4	231	1012.9	2.0	21.3	21.3
Sa	120890	0700	739.4	232	1013.1	3.0	21.5	21.5
Sa	120890	0800	743.9	233	1013.7	3.0	NA	23.5
Sa	120890	0900	750.2	234	1013.9	2.5	21.4	23.5
Sa	120890	1000	756.2	235	1014.1	2.0	21.5	22.3
Sa	120890	1100	761.9	236	1013.8	2.0	21.4	22.4
Sa	120890	1200	767.0	237	1013.3	2.0	21.3	NA
Sa	120890	1300	773.0	238	1012.4	2.5	21.2	23.0
Sa	120890	1400	778.4	239	1011.7	2.0	21.2	22.0
Sa	120890	1500	782.5	240	1011.5	2.0	21.2	21.9
Sa	120890	1600	788.8	241	1011.5	2.0	21.2	21.7
Sa	120890	1700	NA	242	1011.7	2.0	21.2	21.8
Sa	120890	1800	NA	243	1012.0	2.0	NA	21.5
Sa	120890	1900	NA	244	1013.0	2.5	21.1	21.5
Sa	120890	2000	NA	245	NA	3.0	NA	NA
Sa	120890	2100	794.0	246	NA	3.0	NA	NA
Sa	120890	2200	NA	247	NA	3.0	NA	NA
Sa	120890	2300	805.1	248	1013.8	3.0	21.2	21.5
Su	120990	0000	811.7	249	1013.4	3.5	21.0	21.0
Su	120990	0100	818.6	250	1013.2	3.5	21.3	21.0
Su	120990	0200	826.3	251	1013.1	4.0	21.2	21.0
Su	120990	0300	833.3	252	1013.4	4.0	21.2	21.1
Su	120990	0400	840.2	253	1014.0	4.0	21.1	21.5
Su	120990	0500	846.6	254	1014.5	4.0	21.8	20.6
Su	120990	0600	852.5	255	1015.0	3.5	21.8	20.0
Su	120990	0700	856.5	256	1015.7	3.0	21.5	20.5
Su	120990	0800	857.6	257	1016.4	3.0	21.8	21.5
Su	120990	0900	861.0	258	1017.5	3.0	22.0	21.9
Su	120990	1000	864.1	259	1017.9	3.0	22.0	21.9
Su	120990	1100	867.0	260	1018.8	3.0	22.0	21.7
Su	120990	1200	869.9	261	1018.6	3.0	22.0	21.7
Su	120990	1300	873.9	262	1018.1	3.0	22.0	22.1
Su	120990	1400	NA	263	NA	3.0	NA	NA
Su	120990	1500	NA	264	NA	NA	NA	NA
Su	120990	1600	878.6	265	1018.8	2.5	22.0	NA
Su	120990	1700	881.4	266	1019.0	2.0	22.0	20.2
Su	120990	1800	886.7	267	1020.5	2.5	21.9	20.5
Su	120990	1900	892.1	268	1021.2	3.5	22.0	19.9
Su	120990	2000	899.9	269	1021.5	2.5	22.0	20.5
Su	120990	2100	906.5	270	1021.7	3.0	21.9	20.5

DAY	DATE	TIME	LOG	CRUISE HOUR	PRESSURE	BF	SEA TEMP	AIR TEMP
Su	120990	2200		271	NA	3.0	NA	NA
Su	120990	2300	917.0	272	1021.7	3.0	21.8	20.5
Mo	121090	0000	920.0	273	1022.2	3.5	21.7	20.9
Mo	121090	0100	924.4	274	1022.4	4.0	21.7	19.9
Mo	121090	0200	932.4	275	1022.6	4.5	21.3	20.0
Mo	121090	0300	936.7	276	1022.6	4.0	NA	19.8
Mo	121090	0400	943.9	277	1022.2	4.0	21.6	20.0
Mo	121090	0500	951.3	278	1022.2	4.0	21.2	20.2
Mo	121090	0600	958.6	279	1022.6	4.0	22.1	20.5
Mo	121090	0700	966.0	280	1023.2	4.0	22.3	20.8
Mo	121090	0800	973.3	281	1023.6	4.0	22.4	20.9
Mo	121090	0900	980.4	282	1024.1	4.0	22.1	21.0
Mo	121090	1000	986.8	283	1024.4	4.0	22.3	20.9
Mo	121090	1100	989:1	284	1024.2	4.0	22.5	21.6
Mo	121090	1200	991.1	285	1023.5	4.0	22.5	21.8
Mo	121090	1300	NA	286	1023.0	4.5	22.5	21.7
Mo	121090	1400	995.0	287	1022.5	5.0	22.3	21.0
Mo	121090	1500	NA	288	1022.3	NA	22.2	20.8
Mo	121090	1600	1006.5	289	1022.4	4.5	22.2	20.5
Mo	121090	1700	NA	290	1022.4	4.0	22.1	20.5
Mo	121090	1800	1020.1	291	1023.3	4.0	22.0	20.5
Mo	121090	1900	1027.1	292	1023.5	4.0	22.3	20.5
Mo	121090	2000	1023.8	293	1023.8	NA	22.3	20.8
Mo	121090	2100	1040.5	294	1023.9	3.5	22.4	20.8
Mo	121090	2200	1046.3	295	1024.1	3.0	22.4	20.9
Mo	121090	2300	1051.8	296	1024.0	3.0	22.4	21.0
Tu	121190	0000	1056.1	297	NA	3.0	NA	NA
Tu	121190	0100	1060.9	298	1023.8	3.0	22.3	20.8
Tu	121190	0200	1065.7	299	1023.5	3.0	22.7	20.9
Tu	121190	0300	1071.8	300	1023.7	3.0	22.7	20.8
Tu	121190	0400	1078.3	301	1023.4	3.0	22.8	20.9
Tu	121190	0500	1084.5	302	1023.5	3.0	22.5	21.1
Tu	121190	0600	1090.2	303	1023.7	3.0	22.8	21.0
Tu	121190	0700	1096.1	304	1023.7	3.0	23.2	21.2
Tu	121190	0800	1102.8	305	1024.6	3.0	23.2	21.3
Tu	121190	0900	1109.8	306	1024.6	3.5	23.2	21.9
Tu	121190	1000	1116.9	307	1025.5	4.0	23.2	21.8
Tu	121190	1100	1120.4	308	1025.2	4.5	23.0	21.8
Tu	121190	1200	NA	309	1024.6	5.0	23.1	22.5
Tu	121190	1300	1123.2	310	1023.7	4.5	22.9	22.0
Tu	121190	1400	1128.1	311	1023.1	4.0	22.8	22.0
Tu	121190	1500	1135.4	312	1022.4	4.0	22.7	21.7
Tu	121190	1600	1140.7	313	1023.0	4.0	22.6	21.9
Tu	121190	1700	1147.2	314	1023.4	3.5	22.8	21.6
Tu	121190	1800	1154.6	315	1023.0	3.5	22.8	21.7
Tu	121190	1900	1161.4	316	1023.4	3.0	22.8	21.5
Tu	121190	2000	1168.1	317	1023.5	3.0	22.6	21.5
Tu	121190	2100	1174.8	318	1023.2	4.0	22.5	21.5
Tu	121190	2200	1181.7	319	1023.2	4.0	22.6	22.0
Tu	121190	2300	1186.4	320	1023.0	4.0	22.6	21.6
Wed	121290	0000	1190.4	321	1022.5	4.0	22.8	21.2
Wed	121290	0100	1194.6	322	1022.7	3.0	22.6	21.3
Wed	121290	0200	1199.6	323	1022.1	3.0	22.8	21.8
Wed	121290	0300	1205.9	324	1021.6	3.0	23.0	21.8

DAY	DATE	TIME	LOG	CRUISE HOUR	PRESSURE	BF	SEA TEMP	AIR TEMP
Wed	121290	0400	1212.1	325	1021.5	3.5	23.1	21.5
Wed	121290	0500	1218.4	326	1021.5	2.5	22.3	21.7
Wed	121290	0600	1225.0	327	1021.5	3.0	22.1	21.3
Wed	121290	0700	1230.8	328	1022.0	3.0	23.1	21.8
Wed	121290	0800	1238.2	329	1022.0	3.0	23.2	21.9
Wed	121290	0900	1245.8	330	1022.0	4.0	22.8	22.1
Wed	121290	1000	1253.7	331	1023.0	3.0	22.7	22.4
Wed	121290	1100	NA	332	1022.5	4.0	22.5	22.6
Wed	121290	1200	NA	333	1021.6	4.0	22.6	NA
Wed	121290	1300	1259.6	334	1021.0	4.0	22.6	22.3
Wed	121290	1400	1263.8	335	1020.2	4.0	22.8	22.5
Wed	121290	1500	1271.1	336	1020.2	4.0	NA	22.4
Wed	121290	1600	1275.2	337	1020.0	4.0	22.7	22.1
Wed	121290	1700	1282.9	338	1020.1	4.0	22.9	21.5
Wed	121290	1800	1287.5	339	1020.4	4.0	22.4	21.5
Wed	121290	1900	1292.9	340	1020.1	4.0	22.7	21.7
Wed	121290	2000	1292.9	341	1021.0	3.0	23.0	21.9
Wed	121290	2100	1293.0	342	1021.0	3.0	23.0	21.9
Wed	121290	2200	1293.0	343	1021.2	3.0	23.0	21.6
Wed	121290	2300	NA	344	1021.5	2.0	23.0	21.2
Thu	121390	0000	1301.5	345	1019.8	3.5	23.3	NA
Thu	121390	0100	1305.2	346	1019.8	3.5	23.3	21.1
Thu	121390	0200	1311.2	347	1018.7	3.5	23.3	21.0
Thu	121390	0300	1316.7	348	1018.7	2.5	23.1	21.2
Thu	121390	0400	1320.8	349	1018.2	2.5	23.2	20.5
Thu	121390	0500	1326.2	350	1018.5	2.5	23.2	19.2
Thu	121390	0600	1332.0	351	1018.9	4.0	23.4	18.9
Thu	121390	0700	1338.4	352	1019.0	4.0	23.4	18.2
Thu	121390	0800	1344.1	353	1019.1	3.0	23.5	21.2
Thu	121390	0900	1349.1	354	1020.0	2.0	23.4	22.9
Thu	121390	1000	1355.3	355	1019.9	3.0	23.6	22.1
Thu	121390	1100	NA	356	1019.4	3.0	23.6	22.8
Thu	121390	1200	NA	357	1019.0	3.0	23.6	22.9
Thu	121390	1300	1359.7	358	1018.4	3.0	23.5	23.1
Thu	121390	1400	1363.9	359	1018.0	3.0	23.6	22.1
Thu	121390	1500	1370.8	360	1017.3	3.0	23.4	22.1
Thu	121390	1600	1375.2	361	1017.1	3.0	22.8	22.4
Thu	121390	1700	1381.6	363	1016.9	3.0	23.7	21.5
Thu	121390	1800	1387.1	364	1017.5	3.0	23.5	21.1
Thu	121390	1900	1394.0	365	1018.0	3.0	23.6	21.4
Thu	121390	2000	1399.6	366	1018.3	3.0	23.7	21.4
Thu	121390	2100	1405.8	367	1018.6	3.0	23.5	21.7
Thu	121390	2200	1412.5	368	1018.8	3.0	23.4	21.8
Thu	121390	2300	1418.5	369	1018.9	3.0	23.3	22.0
Fri	121490	0000	1422.3	370	1018.6	2.5	23.3	21.6
Fri	121490	0100	1427.0	371	1018.4	2.5	23.4	21.6
Fri	121490	0200	1434.6	372	1017.9	2.0	23.3	21.8
Fri	121490	0300	1440.0	373	1016.8	2.0	22.9	21.8
Fri	121490	0400	1445.8	374	1016.7	2.5	22.8	21.7
Fri	121490	0500	1454.0	375	1016.7	2.5	22.9	21.8
Fri	121490	0600	1457.5	376	1017.0	3.0	23.1	21.8
Fri	121490	0700	1463.7	377	1017.3	2.5	23.6	21.7
Fri	121490	0800	1470.2	378	1017.9	4.0	24.0	22.6
Fri	121490	0900	1476.8	379	1017.9	4.0	24.0	22.8

DAY	DATE	TIME	LOG	CRUISE HOUR	PRESSURE	BF	SEA TEMP	AIR TEMP
Fri	121490	1000	1483.4	380	1018.5	4.0	24.0	23.3
Fri	121490	1100	1485.6	381	1018.1	4.0	24.0	23.8
Fri	121490	1200	NA	382	1017.2	4.0	24.0	23.8
Fri	121490	1300	1490.2	383	1016.9	4.0	24.0	23.1
Fri	121490	1400	1496.7	384	1015.5	4.0	NA	23.5
Fri	121490	1500	1504.9	385	NA	4.0	NA	NA
Fri	121490	1600	NA	386	NA	4.0	NA	NA
Fri	121490	1700	1518.4	387	1015.2	4.0	23.8	22.3
Fri	121490	1800	1525.0	388	1015.7	4.0	24.1	22.5
Fri	121490	1900	1532.1	389	1016.5	3.5	24.0	22.4
Fri	121490	2000	1538.3	390	1017.2	3.0	23.8	22.7
Fri	121490	2100	1544.3	391	1017.7	3.0	23.9	22.6
Fri	121490	2200	1551.0	392	1017.7	3.0	24.0	22.7
Fri	121490	2300	1555.8	393	1017.4	3.0	24.0	22.8
Sat	121590	0000	1558.5	394	1016.4	2.5	23.8	22.8
Sat	121590	0100	1565.0	395	1016.9	3.0	23.7	21.1
Sat	121590	0200	1569.8	396	1016.1	3.0	23.8	21.2
Sat	121590	0300	1575.6	397	1015.9	2.5	23.7	20.8
Sat	121590	0400	1580.4	398	1015.9	2.5	23.7	22.4
Sat	121590	0500	1587.2	399	1016.1	2.0	23.8	22.4
Sat	121590	0600	1592.7	400	1016.2	2.5	23.7	22.8
Sat	121590	0700	1597.6	401	1016.5	2.0	23.7	22.0
Sat	121590	0800	1604.1	402	1017.0	3.0	23.7	22.1
Sat	121590	0900	1610.0	403	1017.4	3.0	24.1	23.8
Sat	121590	1000	1619.0	404	1017.5	3.0	24.2	23.5
Sat	121590	1100	1619.6	405	1017.0	3.0	24.3	24.0
Sat	121590	1200	1621.8	406	1016.4	3.0	24.4	23.8
Sat	121590	1300	1622.9	407	1016.1	3.0	24.3	NA
Sat	121590	1400	1622.9	408	NA	3.0	NA	NA
Sat	121590	1500	1626.0	409	1016.2	3.5	24.3	21.3
Sat	121590	1600	1629.5	410	1016.5	3.0	24.3	NA
Sat	121590	1700	1633.6	411	1017.0	3.0	24.3	21.5
Sat	121590	1800	1638.9	412	1017.4	3.0	24.2	23.0
Sat	121590	1900	1645.1	413	1017.6	3.0	24.2	23.2
Sat	121590	2000	1652.2	414	1018.4	3.0	24.2	23.0
Sat	121590	2100	1658.5	415	1018.7	3.0	24.1	22.6
Sat	121590	2200	1664.5	416	1018.6	3.0	24.0	22.9
Sat	121590	2300	1669.2	417	1018.0	3.0	23.9	22.8

CC-115 Tar and Plastic Data

TOW #	DATE	TIME	LATITUDE	LONGITUDE	LOG	TOW A PLASTIC PIECES	TOW A PLASTIC PELLETS	TOW A AGE	TOW A TAR (ML)	TOW A AGE	TOW A ~~PLASTIC~~ (#/KM2) PIECES	TOW A (#/KM2) PELLETS	TOW A TAR (ML/KM	TOW A TOW AREA	TOW B PLASTIC PIECES	TOW B PLASTIC PELLETS	TOW B AGE	TOW B TAR (ML)	TOW B AGE	TOW B ~~PLASTIC~~ (#/KM2) PIECES	TOW B (#/KM2) PELLETS	TOW B TAR (ML/KM	TOW B TOW AREA
1	12/07/90	1555	30.85	16.15	684.60	19	1	FRESH	1.75	1	10259.18	539.96	944.92	0.001852	0	0		0.00					0.000000
2	12/09/90	1158	29.18	16.37	869.80	0	0		3.25	2	0.00	0.00	1754.86	0.001852	0	0		0.00					0.000000
3	12/09/90	2240	28.75	17.17	916.80	0	0		0.50	1	0.00	0.00	269.98	0.001852	2	2	FRESH	7.50	3	1079.91	1079.91	4049.68	0.001852
4	12/10/90	1310	27.08	18.07	992.00	11	3	OLD	3.50	3	5939.52	1619.87	1889.85	0.001852	7	1	FRESH	3.45	2	3779.70	539.96	1862.85	0.001852
5	12/10/90	2300	26.83	18.23	1051.80	7	2	MIXED	6.00	3	3779.70	1079.91	3239.74	0.001852	6	2	FRESH	5.00	3	3239.74	1079.91	2699.78	0.001852
6	12/11/90	1235	25.65	18.80	1121.10	1	0	OLD	1.00	1	490.87	0.00	490.87	0.002037	3	1	OLD	1.00	3	1472.61	490.87	490.87	0.002037
7	12/11/90	2237	24.62	19.30	1185.20	1	0	FRESH	1.50	2	539.96	0.00	809.94	0.001852	1	0	MIXED	2.50	2	539.96	0.00	1349.89	0.001[illegible]
8	12/12/90	1312	23.40	20.22	1260.60	0	0		0.50	2	0.00	0.00	269.98	0.001852	0	0	FRESH	7.00	2	0.00	0.00	3779.70	0.001852
9	12/12/90	2218	22.80	20.58	1294.30	1	1	OLD	5.50	1	539.96	539.96	2969.76	0.001852	1	0		1.50	1	539.96	0.00	809.94	0.001852
10	12/13/90	1248	21.88	21.48	1359.20	0	0		0.75	2	0.00	0.00	368.15	0.002037	0	0	FRESH	0.50	1	0.00	0.00	245.43	0.002037
11	12/13/90	2234	21.12	21.92	1415.70	0	0		1.00	3	0.00	0.00	539.96	0.001852	0	0		0.00		0.00	0.00	0.00	0.002037
12	12/14/90	1313	20.28	23.03	1486.90	0	0		0.50	3	0.00	0.00	269.98	0.001852	0	0		0.25	1	0.00	0.00	134.99	0.001852
13	12/14/90	2235	19.92	23.85	1553.90	0	0		0.75	3	0.00	0.00	404.97	0.001852	0	0		0.50	3	0.00	0.00	269.98	0.001852
14	12/15/90	1106	19.97	25.05	1619.80	0	0		1.75	2	0.00	0.00	944.92	0.001852	0	0		2.25	3	0.00	0.00	1214.90	0.001852
15	12/15/90	2235	19.73	26.22	1668.90	0	0		0.00		0.00	0.00	0.00	0.001852	0	0		3.00	3	0.00	0.00	1472.61	0.002037

CC-115 *Halobates* Data

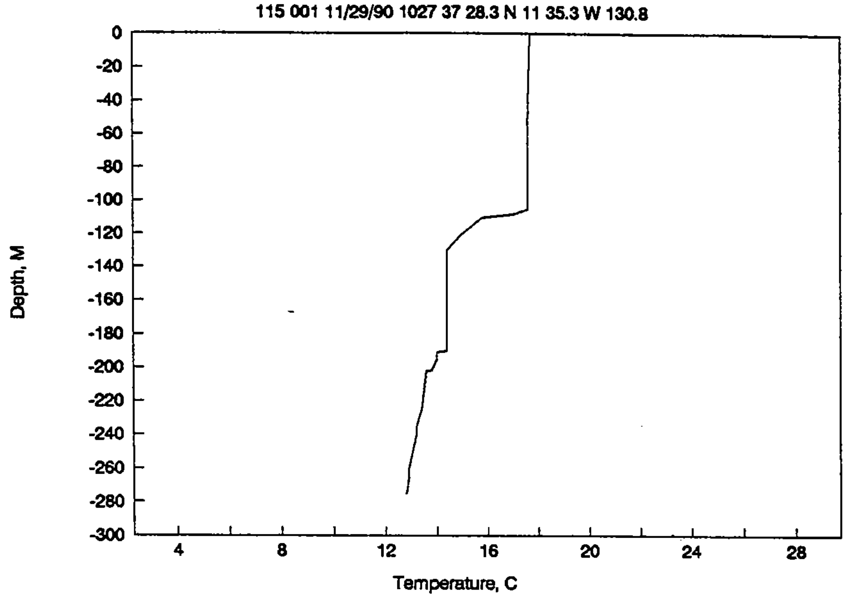
TOW #	DATE	TIME	LATITUDE	LONGITUDE	LOG	TOW SPEED	# OF ADULTS	# OF JUV.	# OF HALOBATES # OF MALES	# OF FEMALES	TOTAL #	TOW SPEED	# OF ADULTS	# OF JUV.	# OF HALOBATES # OF MALES	# OF FEMALES	TOTAL #
1	12/07/90	1555	30 51'	16 9'	684.6	3	1	0	1	0	1						
2	12/09/90	1158	29 11'	16 21.8'	869.8	2.72	2	0	1	1	2						
3	12/09/90	2240	28 45'	17 10'	916.8	1.87	0	0	0	0	0	2.2	3	0	1	2	3
4	12/10/90	1310	27 05'	18 04'	992	4.61	1	0	0	1	1	3.15	0	0	0	0	0
5	12/10/90	2300	26 50'	18 14'	1051.8	2.39	55	11	30	25	66	3.15	50	5	26	24	55
6	12/11/90	1235	25 39'	18 48'	1121.1	4.39	2	0	0	2	2	3.89	0	0	0	0	0
7	12/11/90	2237	24 37'	19 17.5'	1185.2	3.32	6	8	2	4	14	2.99	5	1	4	1	6
8	12/12/90	1312	23 24'	20 13'	1260.6	3.5	0	0	0	0	0	2.3	0	0	0	0	0
9	12/12/90	2218	22 48.4'	20 34.9'	1294.3	2.72	0	0	0	0	0	2.39	7	6	3	4	13
10	12/13/90	1248	21 53.2'	21 28.9'	1359.2	2.99	2	0	1	1	2	2.99	0	1	0	0	1
11	12/13/90	2234	21 6.9'	21 55'	1415.7	2.6	2	0	2	0	2	3.89					
12	12/14/90	1313	20 16.6	23 02'	1486.9	3.75	0	0	0	0	0	4.84	1	1	0	1	2
13	12/14/90	2235	19 54.9'	23 51.0'	1553.9	2.4	17	3	8	9	20	1.5	5	3	2	3	8
14	12/15/90	1106	19 57.7'	25 3.0'	1619.8	2.3	1	2	0	1	3	1.6	0	0	0	0	0
15	12/15/90	2235	19 44.0'	26 13.0'	1668.9	3.3	5	9	2	3	14	2.6	6	5	4	2	11
16	12/16/90	1035	19 26.5	27 27.5'	1734.2	3.5	0	1	0	0	1	3.7	3	6	1	2	9
17	12/17/90	35	18 53.0'	28 28.5'	1806.9	2.4	3	1	1	2	4	4.2	4	6	2	2	10
18	12/17/90	1341	18 31.0'	29 57.0'	1868.7	2.8	0	0	0	0	0	2.7	0	0	0	0	0
19	12/17/90	2236	18 08.4'	30 50.0'	1924.9	1.7	6	6	3	3	12	1.9	3	6	1	2	9
20	12/18/90	1238	17 38.5'	32 11.5'	1999.6	2.7	2	3	1	1	5	2.4	1	1	0	1	2
21	12/18/90	2239	17 32.9'	33 07.8'	2058.2	2.8	17	16	9	8	33	1.5	5	21	3	2	26
22	12/19/90	1043	17 00.2'	34 21.5'	2125.7	2	5	4	3	2	9	2.6	1	11	0	1	12
23	12/19/90	2200	17 12.0'	35 22.0'	2187.1	2.7	25	70	12	13	95	1.5	8	2	6	2	10
24	12/20/90	1033	17 31.0'	36 21.0'	2252.1	3.5	4	7	2	2	11	3.3	2	10	1	1	12

Appendix C

MBT DATA

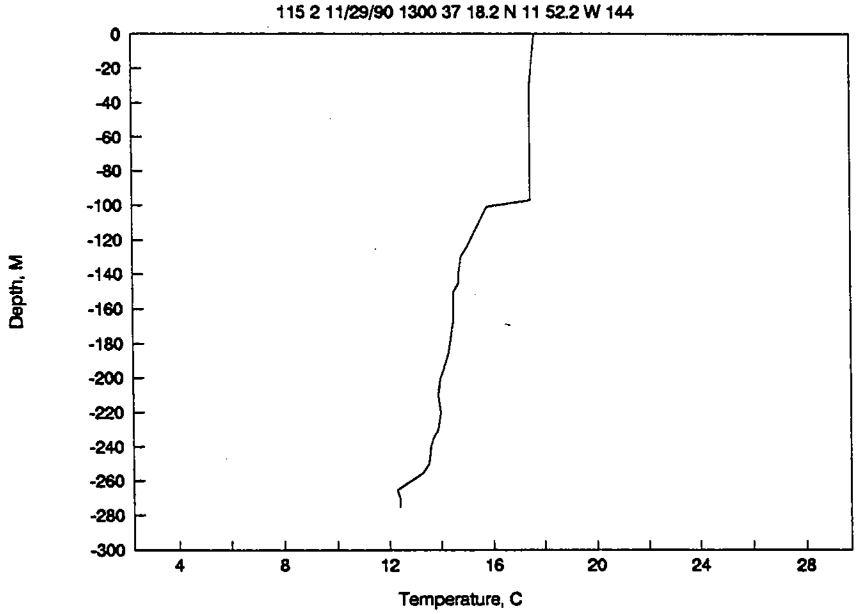
MBT-001

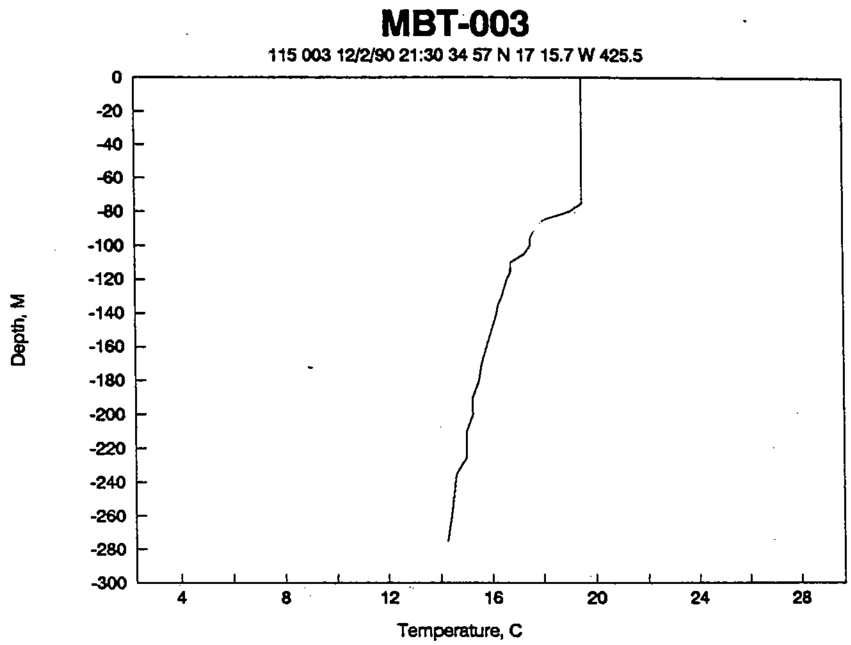
115 001 11/29/90 1027 37 28.3 N 11 35.3 W 130.8

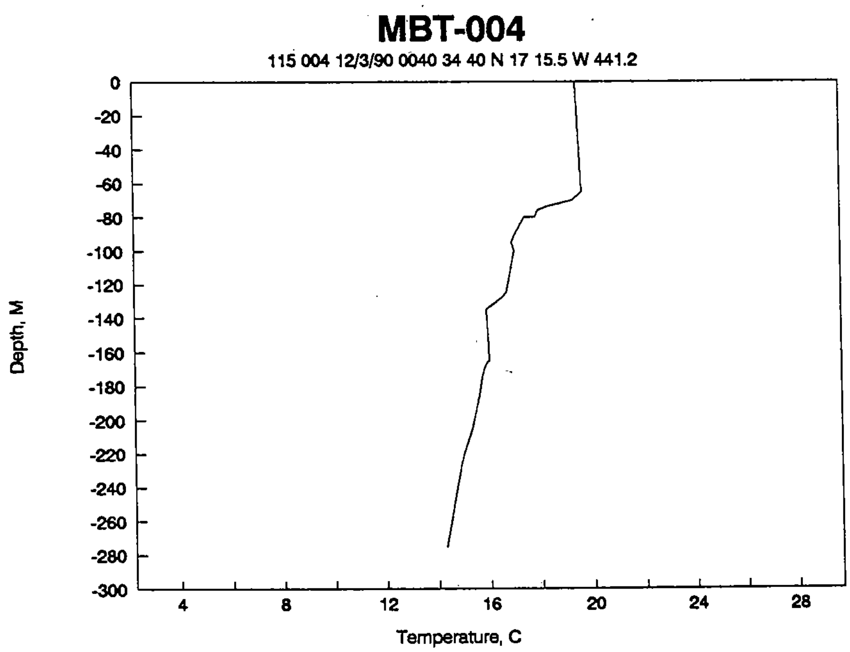


MBT-002

115 2 11/29/90 1300 37 18.2 N 11 52.2 W 144

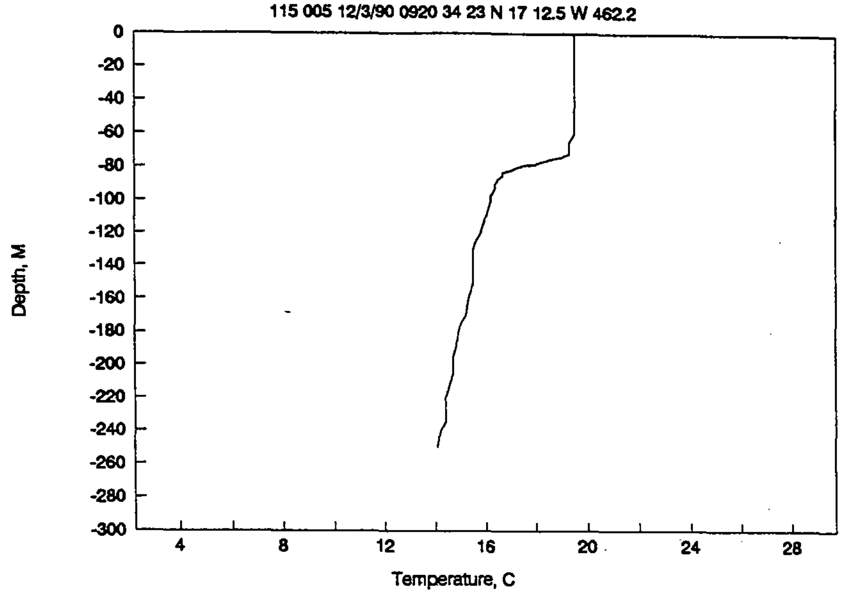



MBT-003
115 003 12/2/90 21:30 34 57 N 17 15.7 W 425.5
Depth, M
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
4
8
12
16
20
24
28
Temperature, C


MBT-004
115 004 12/3/90 0040 34 40 N 17 15.5 W 441.2
Depth, M
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
4
8
12
16
20
24
28
Temperature, C

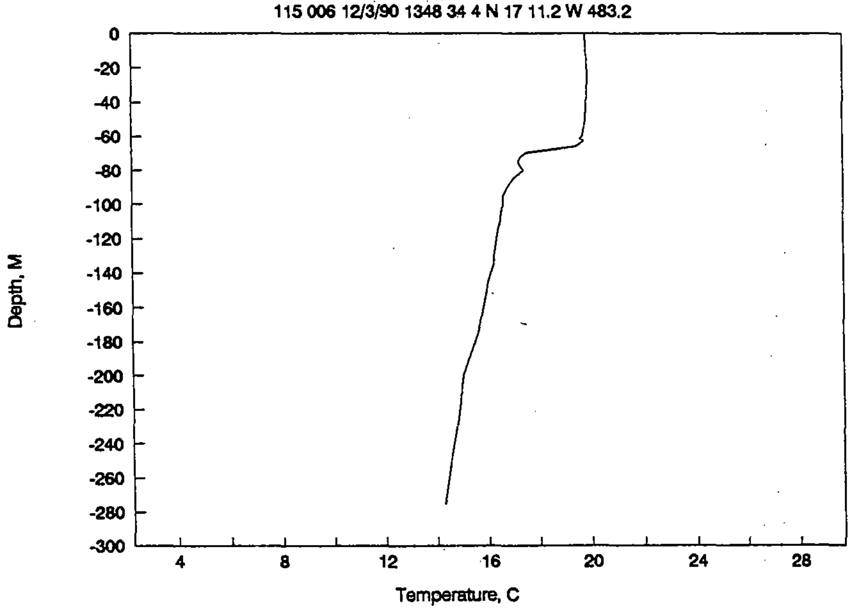
MBT-005

115 005 12/3/90 0920 34 23 N 17 12.5 W 462.2



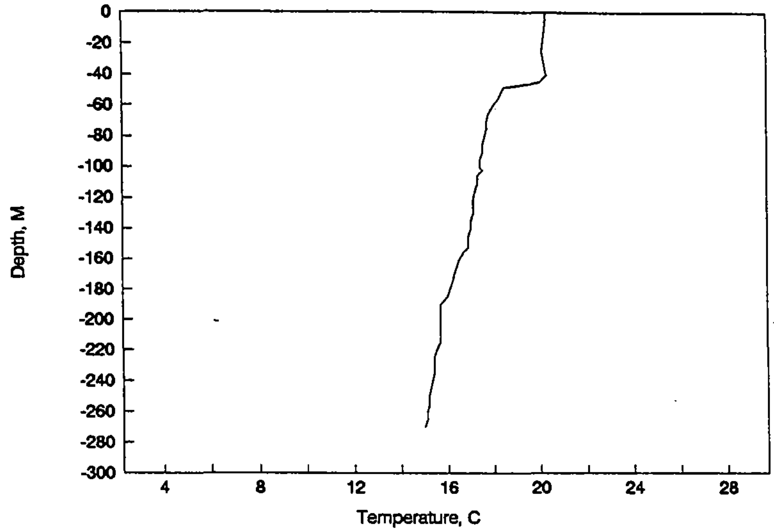
MBT-006

115 006 12/3/90 1348 34 4 N 17 11.2 W 483.2



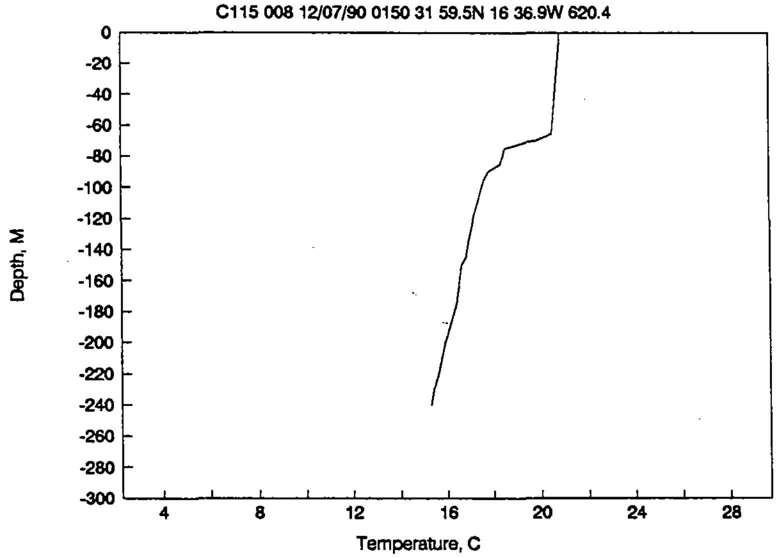
MBT-007

115 007 12/6/90 2347 32 11.7 N 16 43 W 607.5



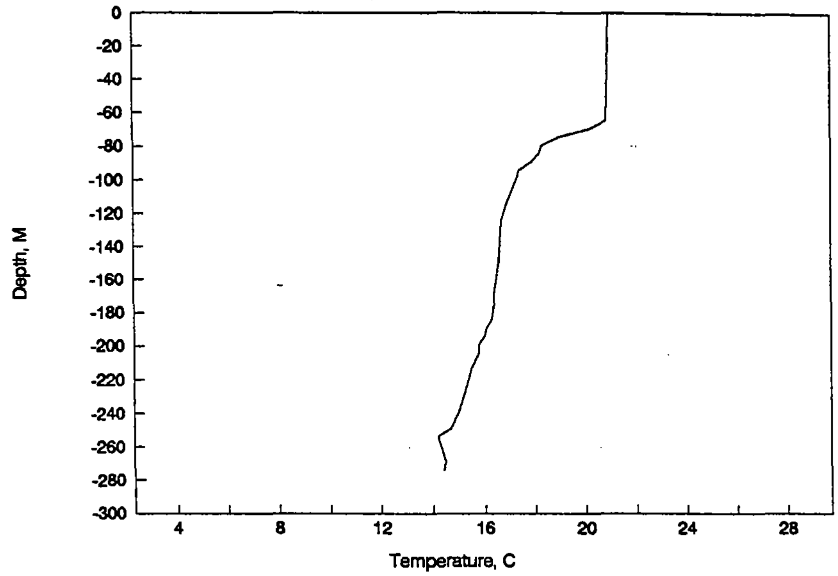
MBT-008

C115 008 12/07/90 0150 31 59.5N 16 36.9W 620.4



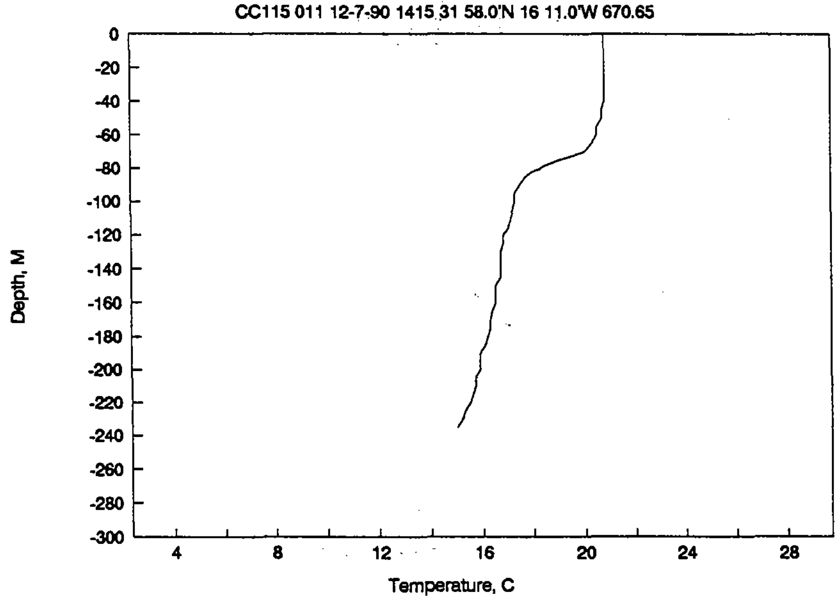
MBT-010

115 010 12/7/90 0930 31 17 N 16 19 W 660.7

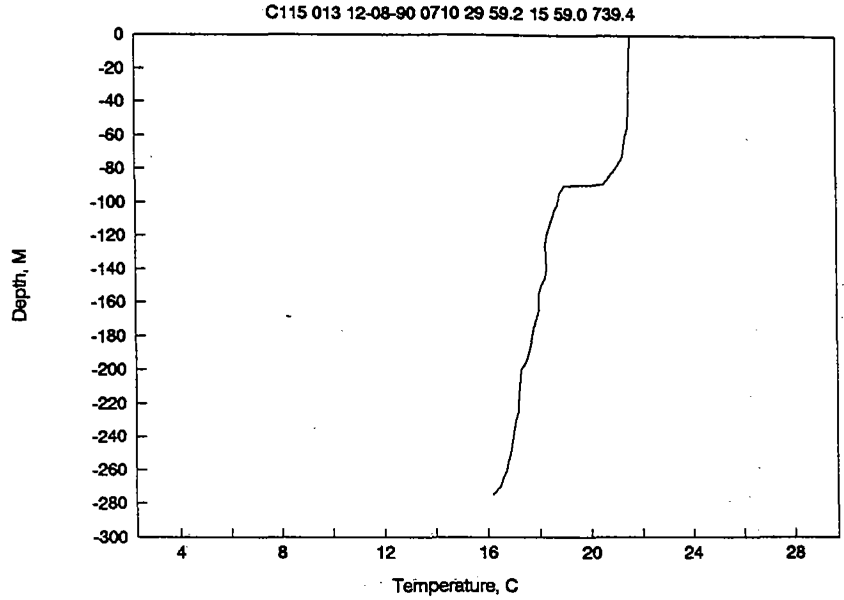


MBT-011

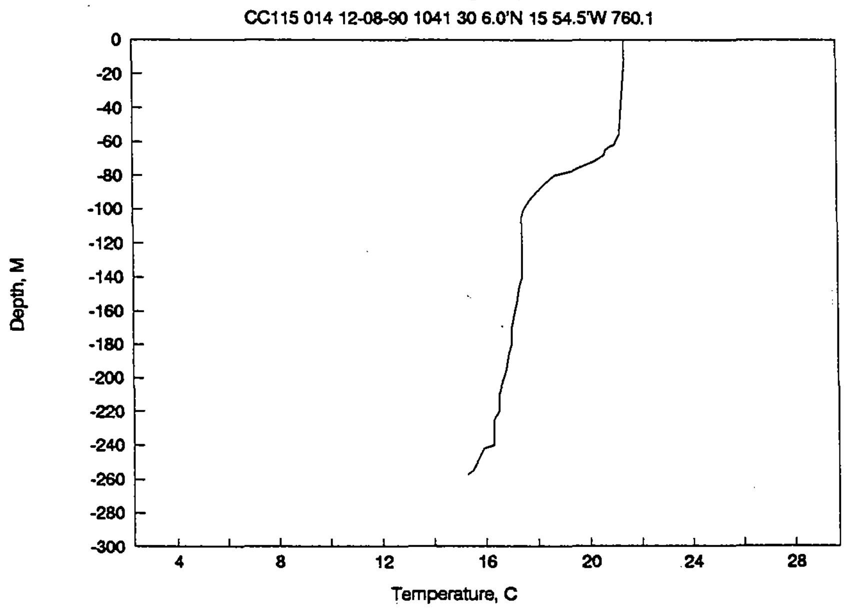
CC115 011 12-7-90 1415 31 58.0'N 16 11.0'W 670.65



MBT-013

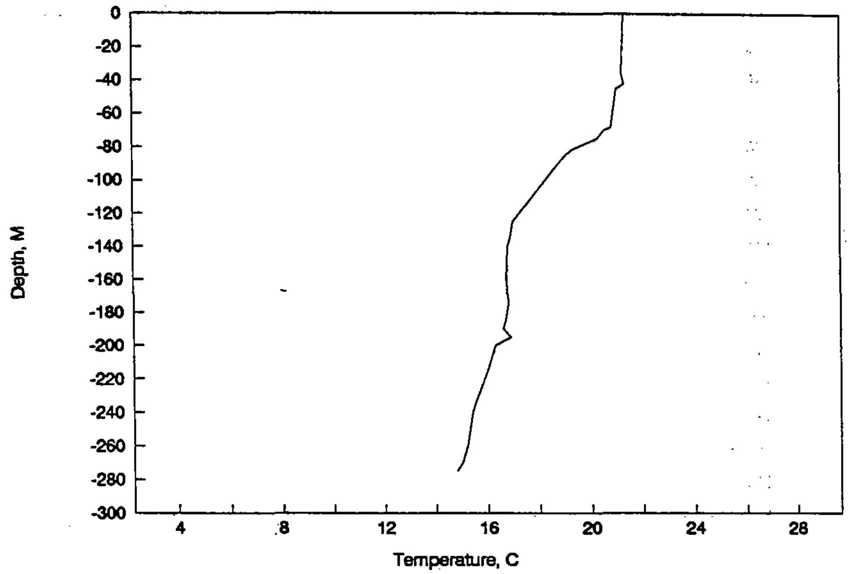


MBT-014



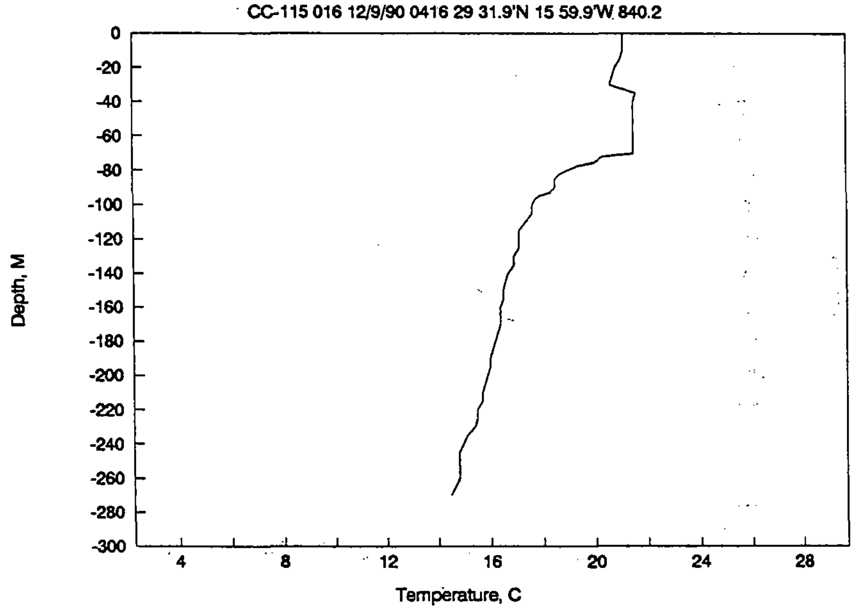
MBT-015

CC115 015 12-9-90 0117 29 52 N 15 51 W 821.4



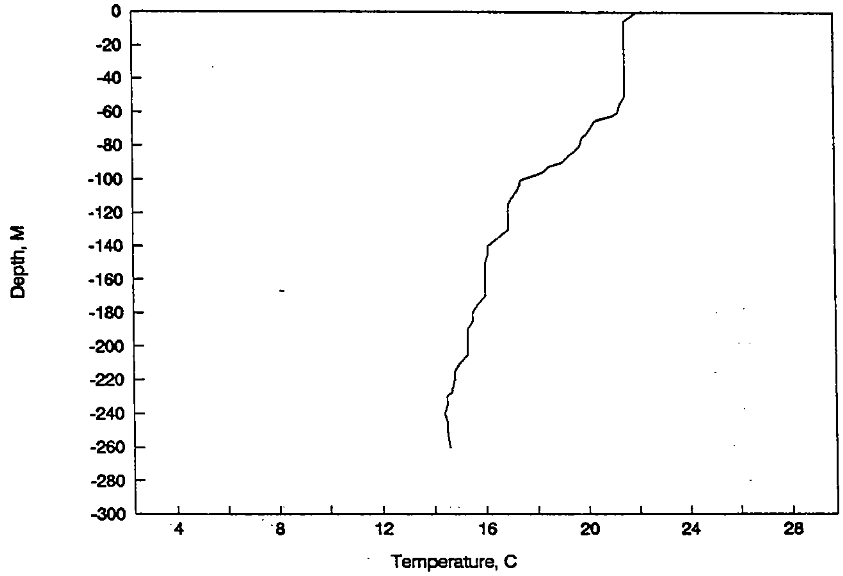
MBT-016

CC-115 016 12/9/90 0416 29 31.9'N 15 59.9'W 840.2



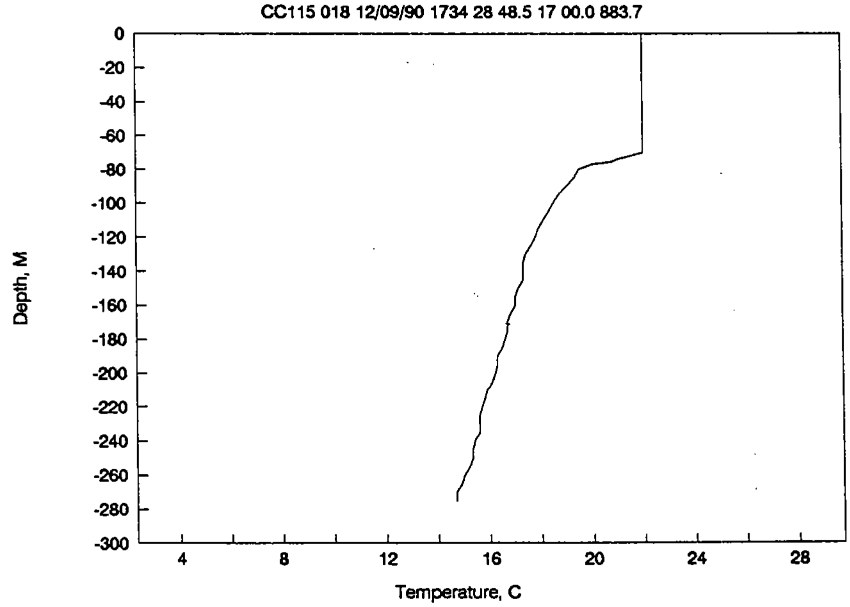
MBT-017

CC-115 017 12/9/90 0900 29 13.6'N 16 12.6'W 861.0



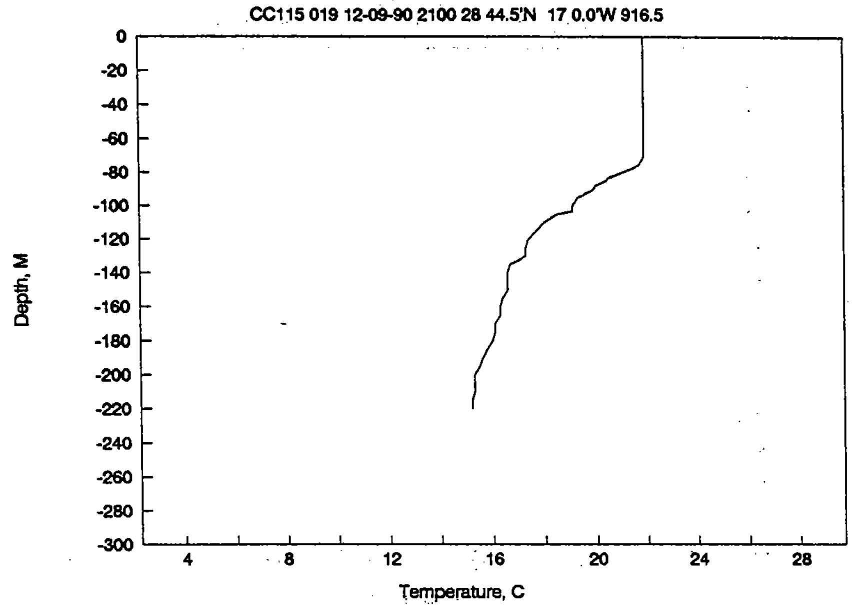
MBT-018

CC115 018 12/09/90 1734 28 48.5 17 00.0 883.7



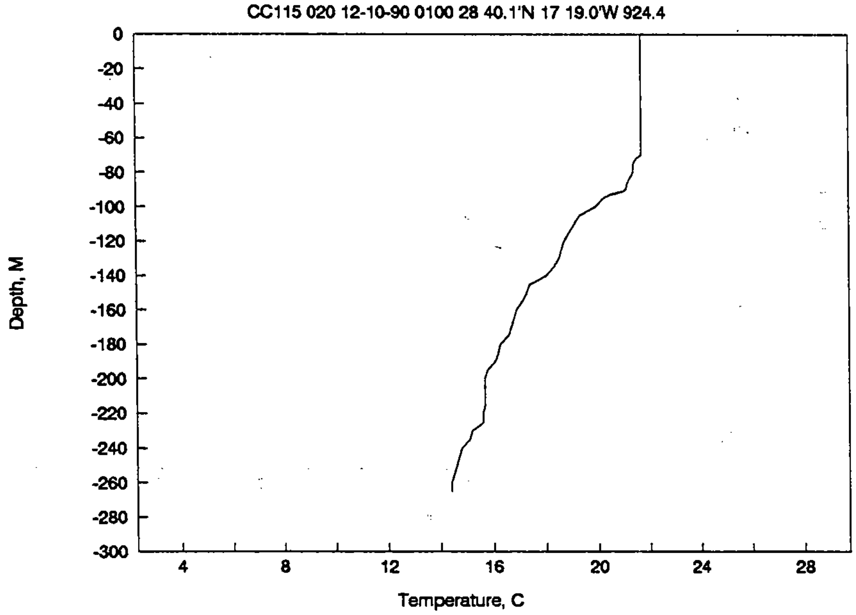
MBT-019

CC115 019 12-09-90 2100 28 44.5'N 17 0.0'W 916.5



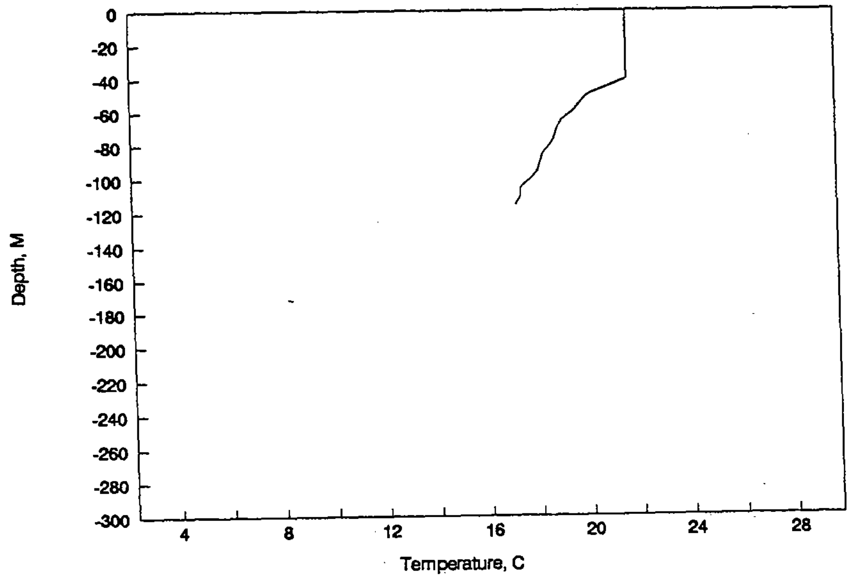
MBT-020

CC115 020 12-10-90 0100 28 40.1'N 17 19.0'W 924.4



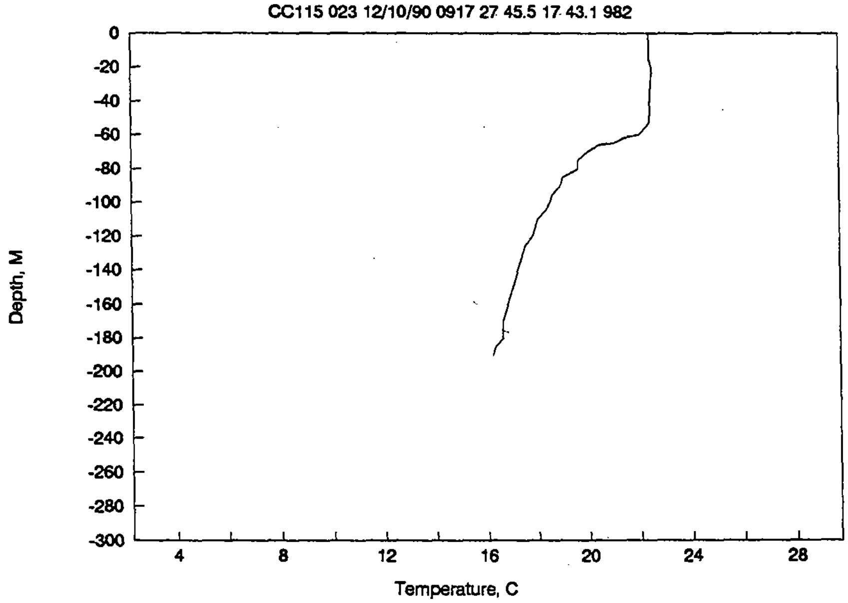
MBT-021

115 021 12/10/90 0420 28 20.3 N 17 37.6 W 947.9



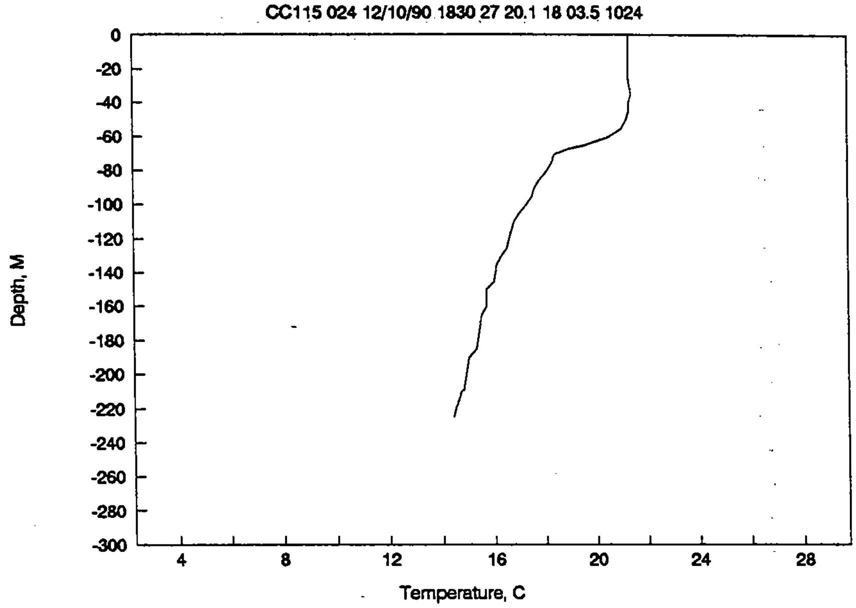
MBT-023

CC115 023 12/10/90 0917 27 45.5 17 43.1 982



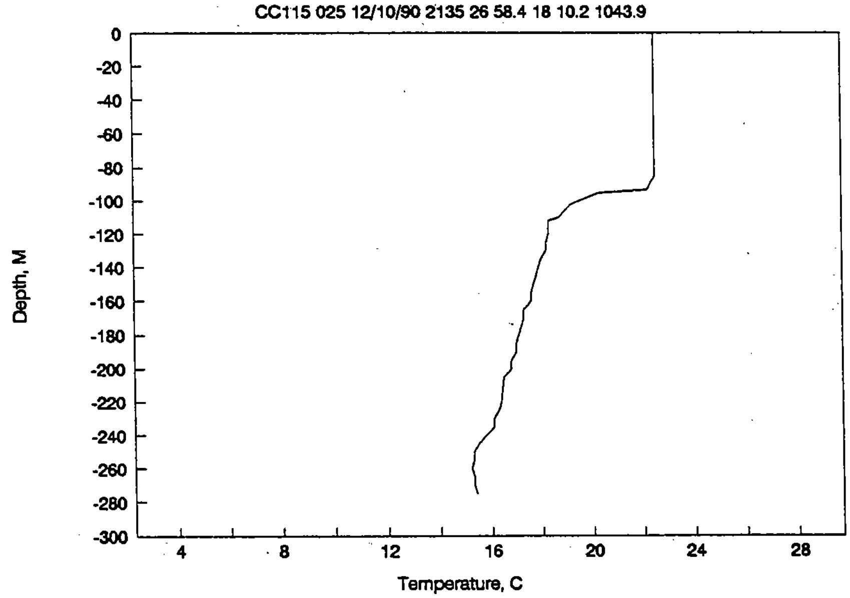
MBT-024

CC115 024 12/10/90 1830 27 20.1 18 03.5 1024



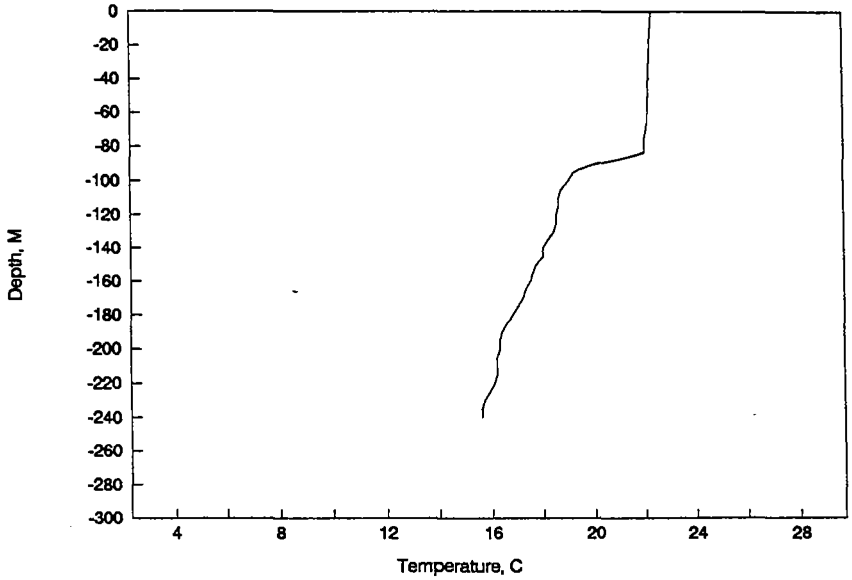
MBT-025

CC115 025 12/10/90 2135 26 58.4 18 10.2 1043.9



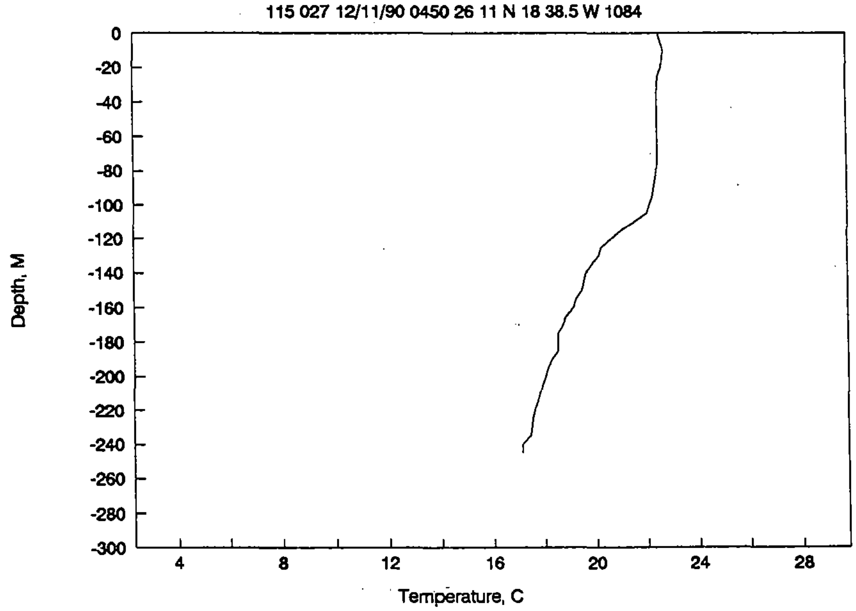
MBT-026

CC115 026 12/11/90 0125 26 27.8 18 23 1063



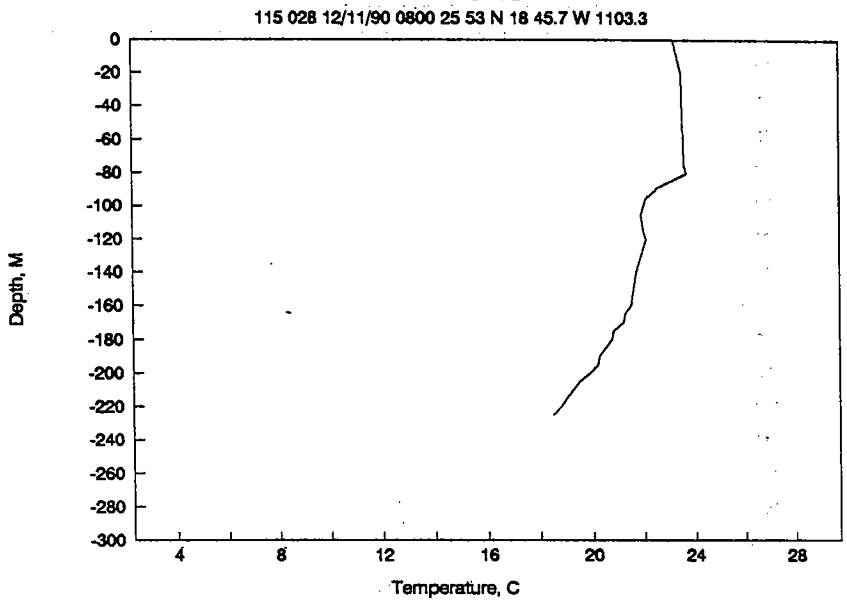
MBT-027

115 027 12/11/90 0450 26 11 N 18 38.5 W 1084



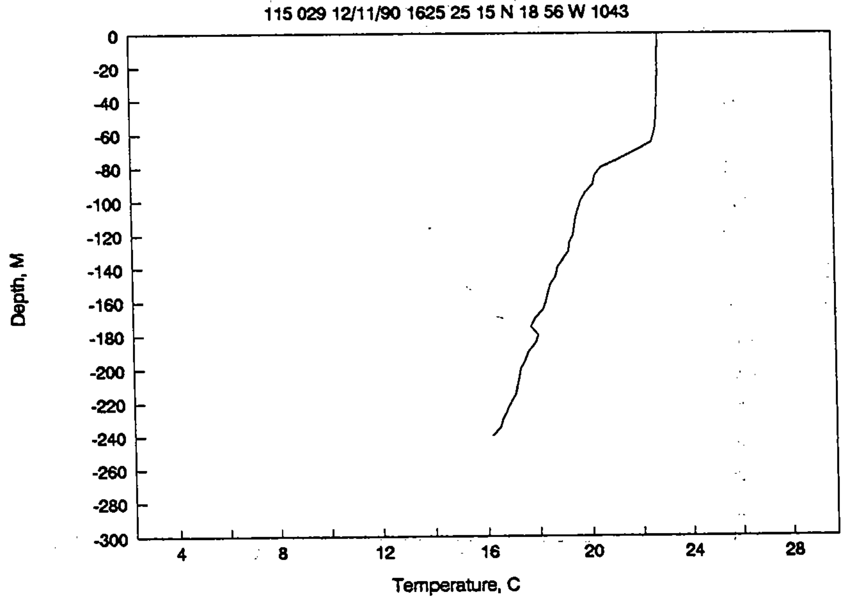
MBT-028

115 028 12/11/90 0800 25 53 N 18 45.7 W 1103.3



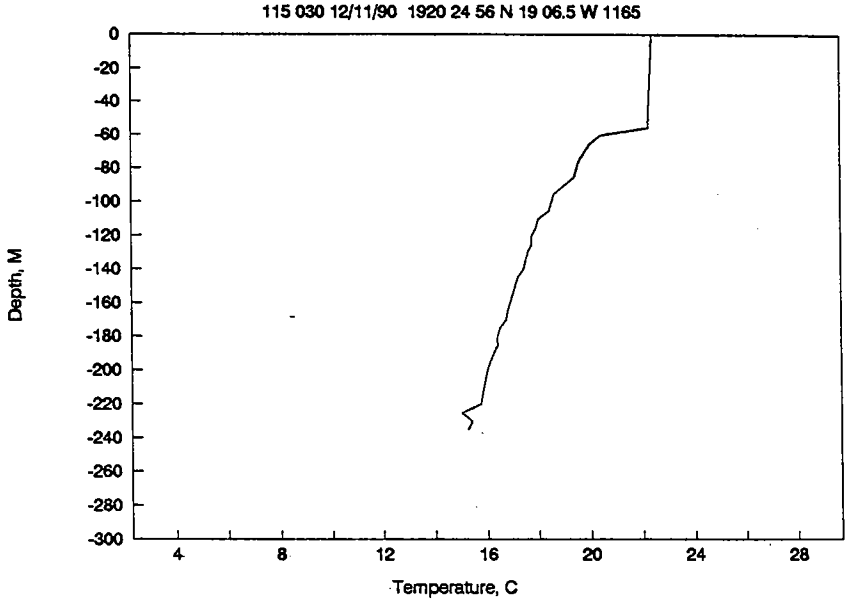
MBT-029

115 029 12/11/90 1625 25 15 N 18 56 W 1043



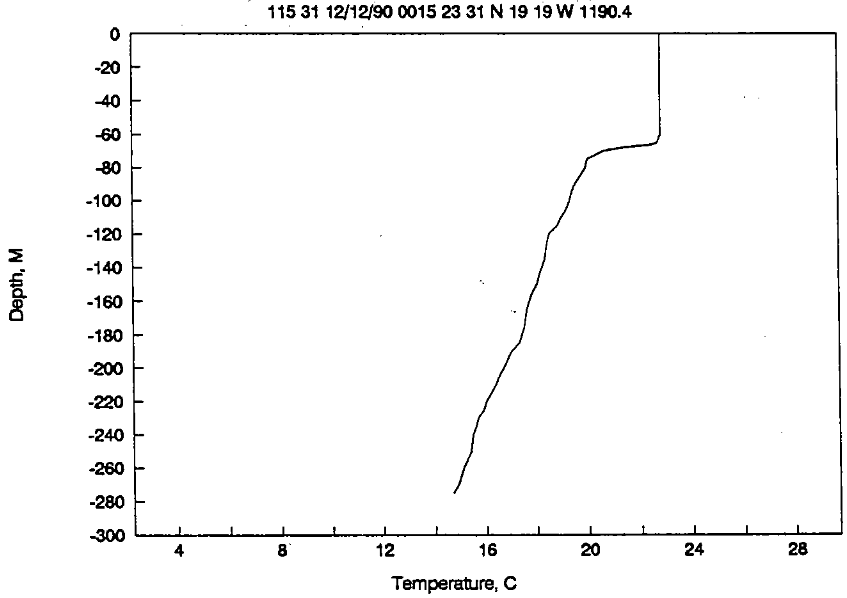
MBT-030

115 030 12/11/90 1920 24 56 N 19 06.5 W 1165



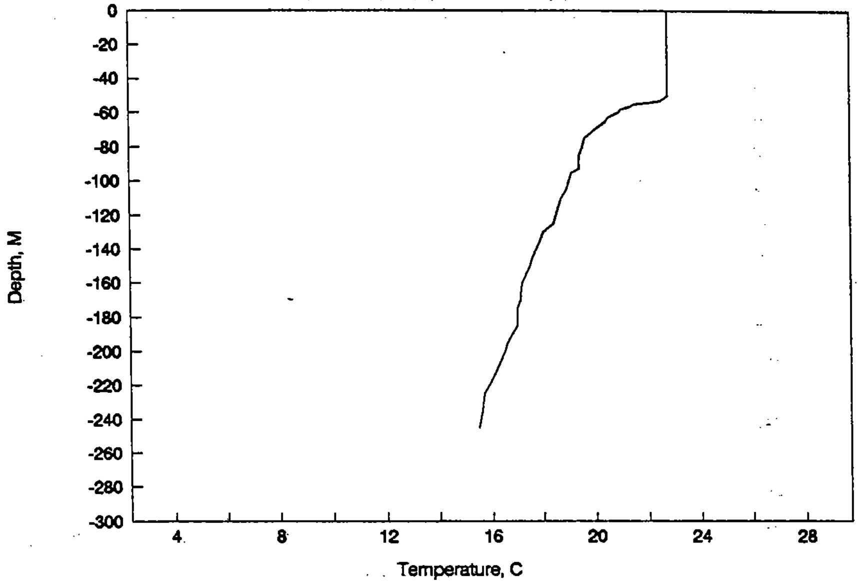
MBT-031

115 31 12/12/90 0015 23 31 N 19 19 W 1190.4



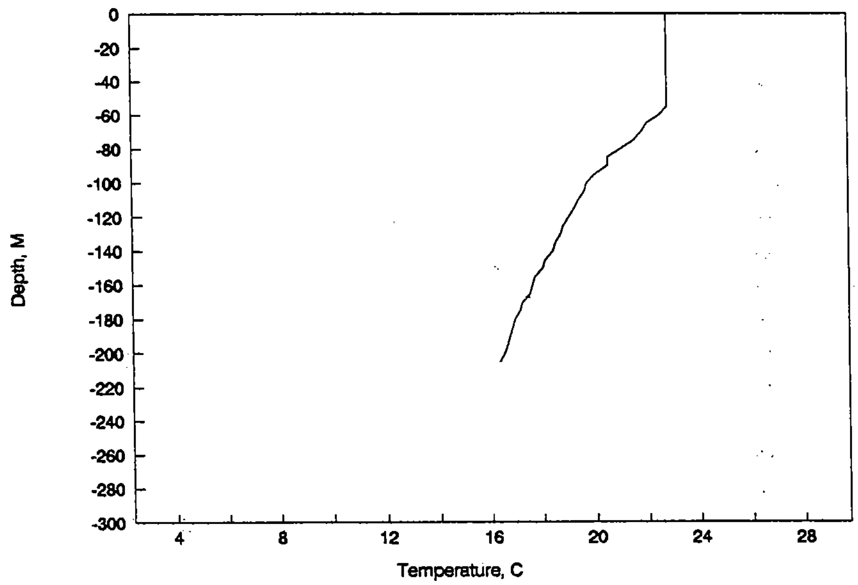
MBT-032

115 32 12/12/90 0325 24 12.5 N 19 26.5 W 1210.4



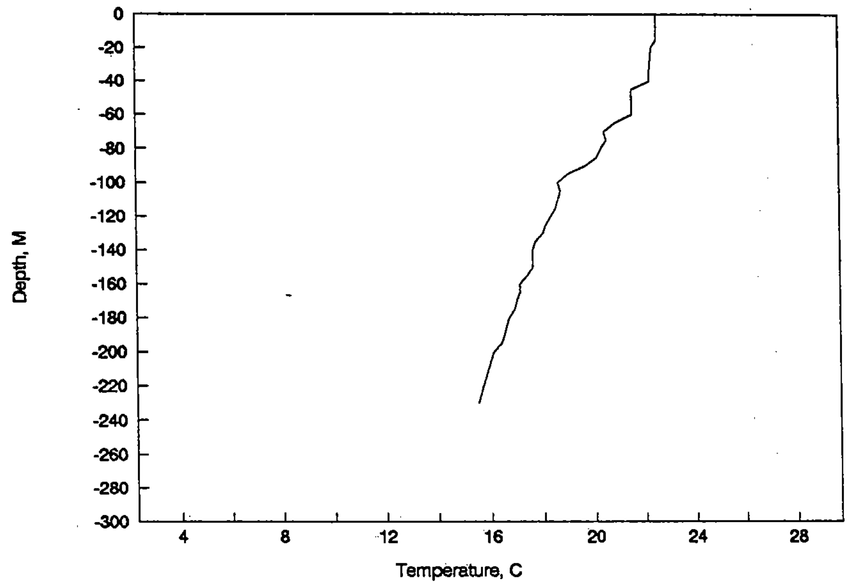
MBT-033

CC115 033 12-12-90 0915 23 35.8' N 20 01.0' W 1247.3



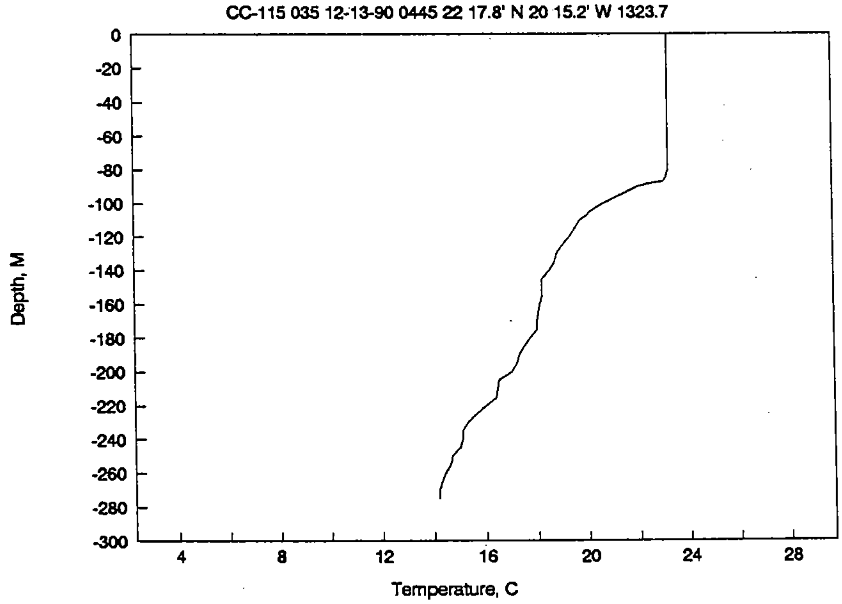
MBT-034

CC115 034 12-12-90 1620 22 48.4' N 20 34.9' W 1277.8



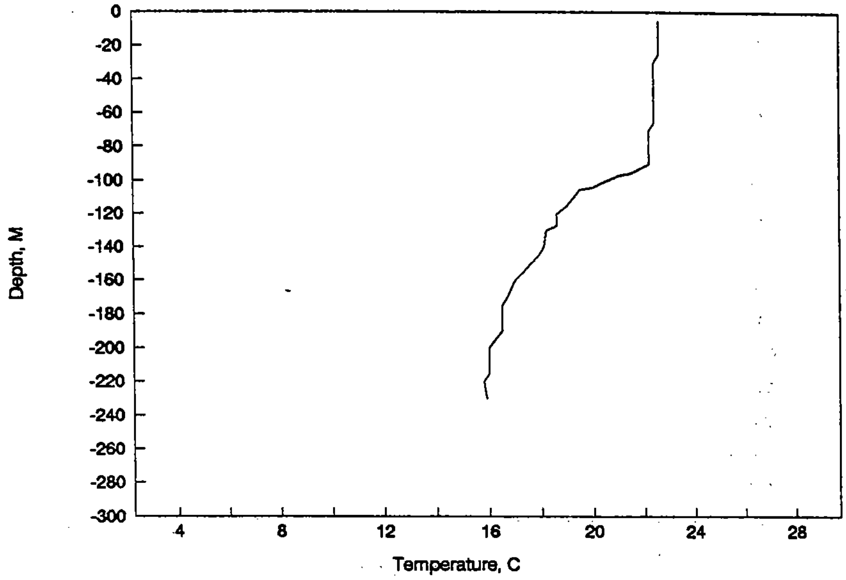
MBT-035

CC-115 035 12-13-90 0445 22 17.8' N 20 15.2' W 1323.7



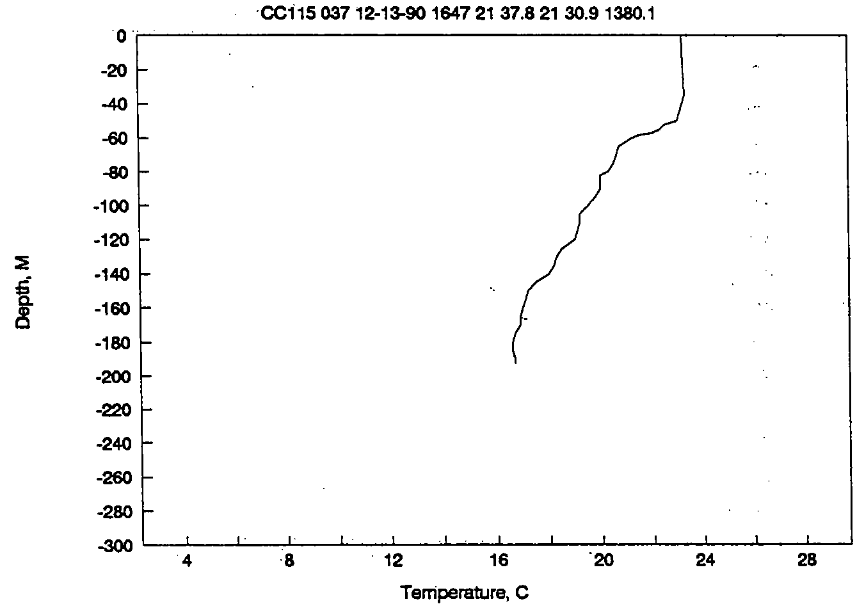
MBT-036

CC115 036 12-13-90 0715 22 11.7 21 30 1339.8



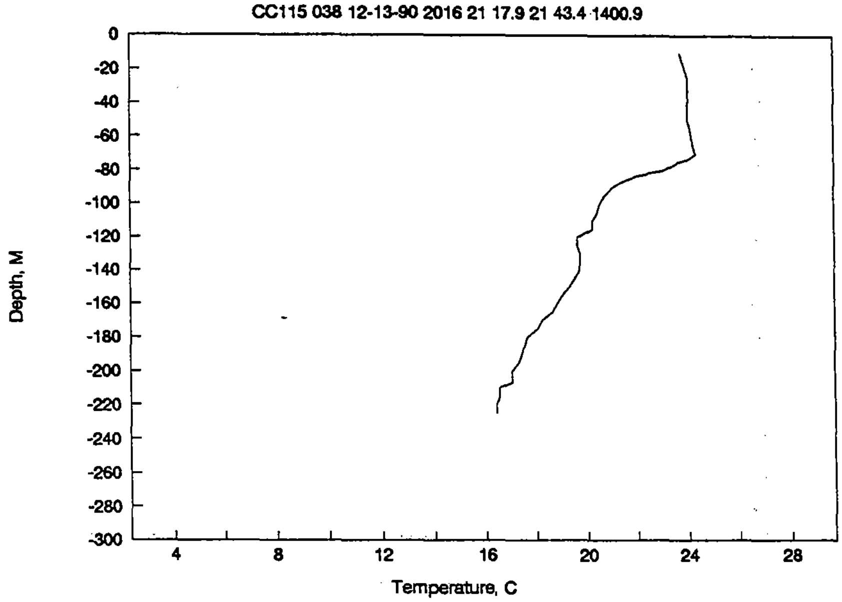
MBT-037

CC115 037 12-13-90 1647 21 37.8 21 30.9 1380.1



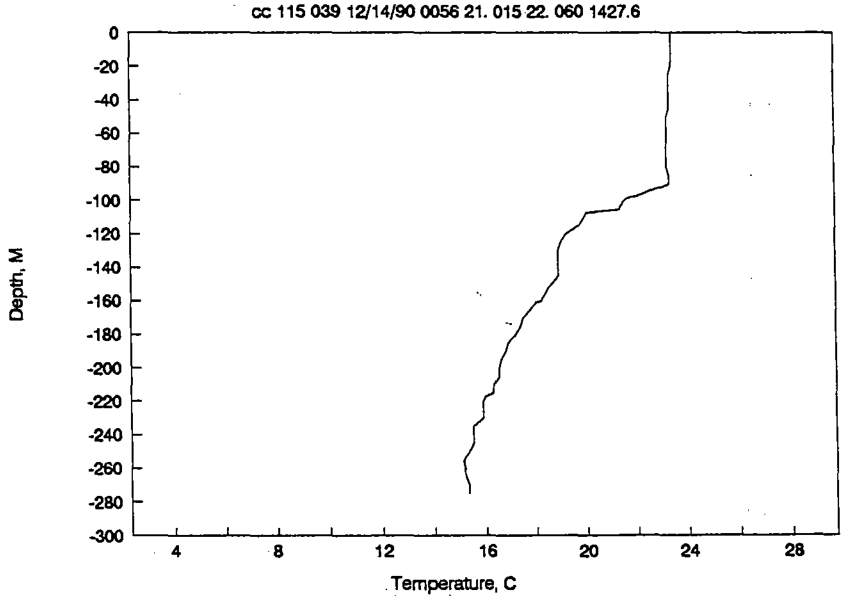
MBT-038

CC115 038 12-13-90 2016 21 17.9 21 43.4 1400.9



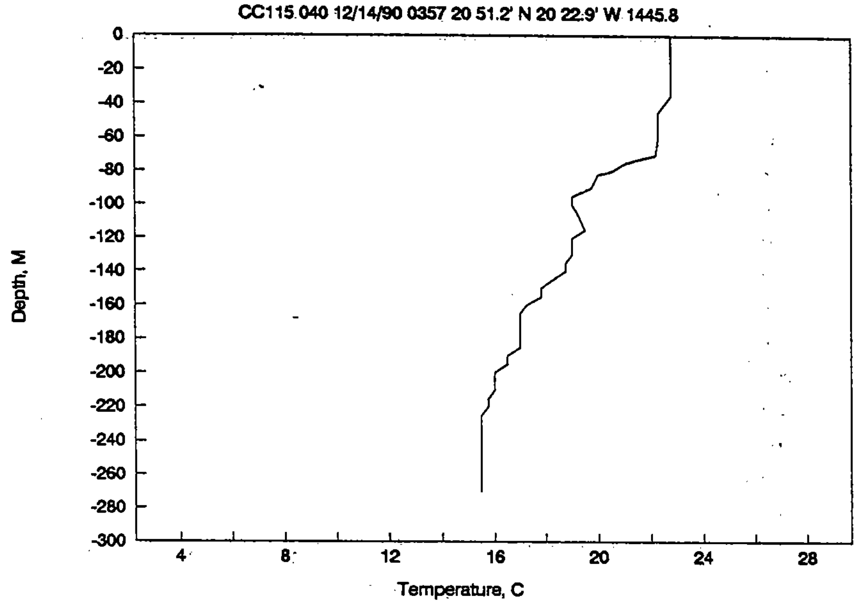
MBT-039

cc 115 039 12/14/90 0056 21. 015 22. 060 1427.6



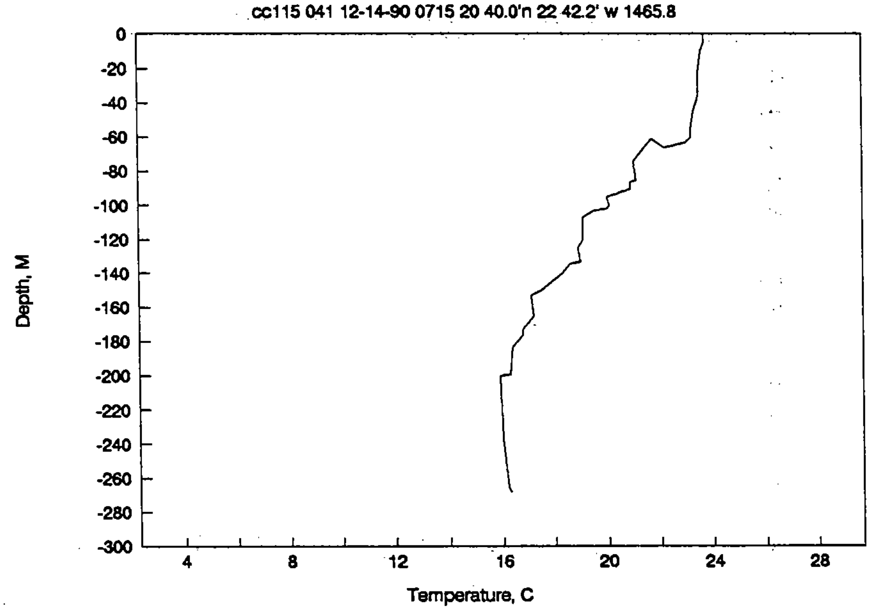
MBT-040

CC115.040 12/14/90 0357 20 51.2' N 20 22.9' W 1445.8



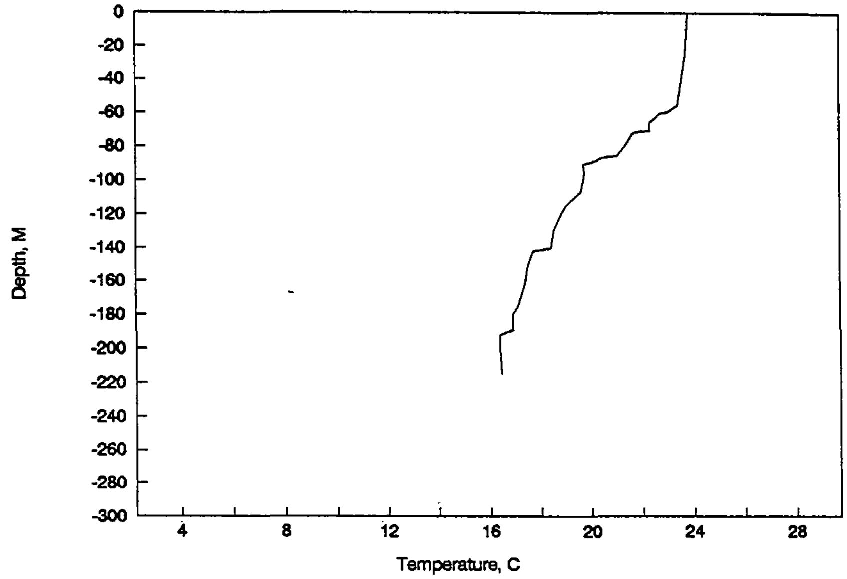
MBT-041

cc115 041 12-14-90 0715 20 40.0'n 22 42.2' w 1465.8



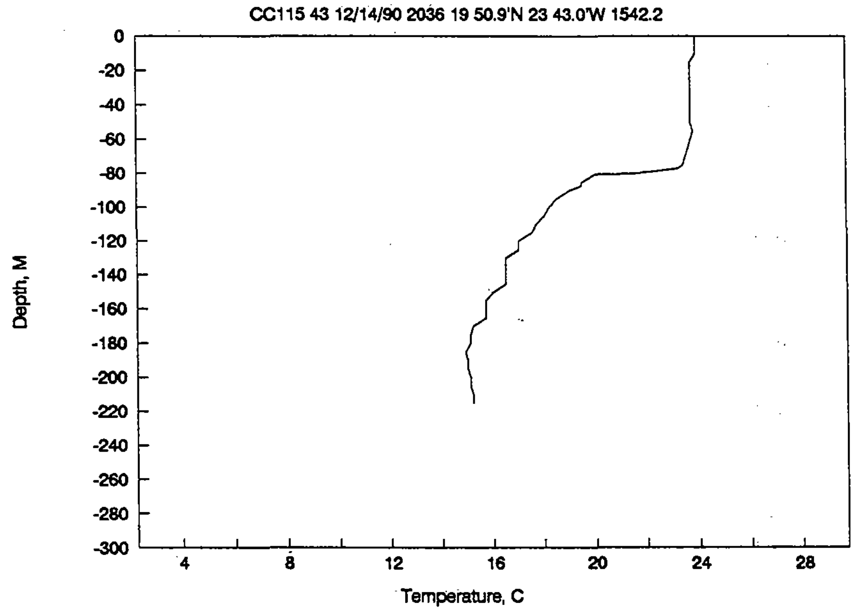
MBT-042

c-115 042 12-14-90 1705 19 48.9'N 23 18.5'W 1519.0



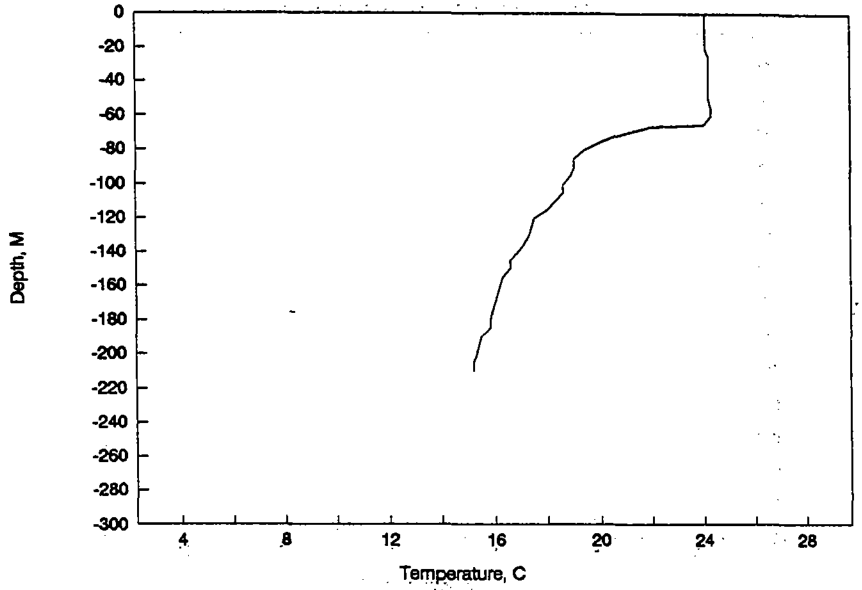
MBT-043

CC115 43 12/14/90 2036 19 50.9'N 23 43.0'W 1542.2



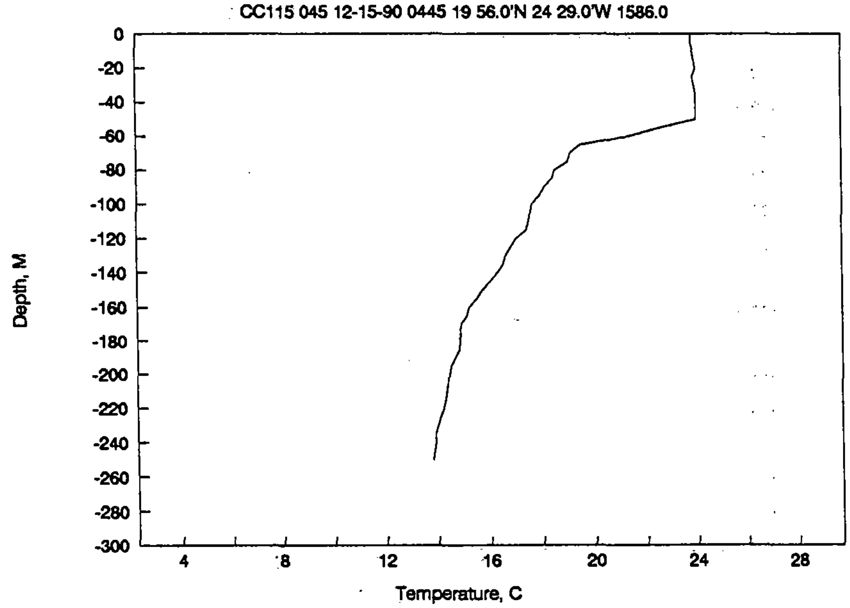
MBT-044

CC115 44 12/15/90 0043 19 54.3'N 24 02.0'W 1562.5



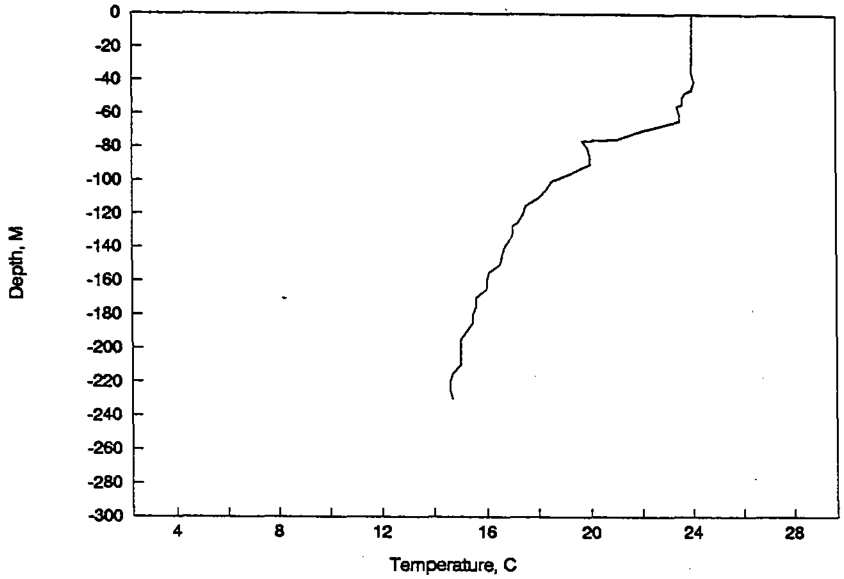
MBT-045

CC115 045 12-15-90 0445 19 56.0'N 24 29.0'W 1586.0



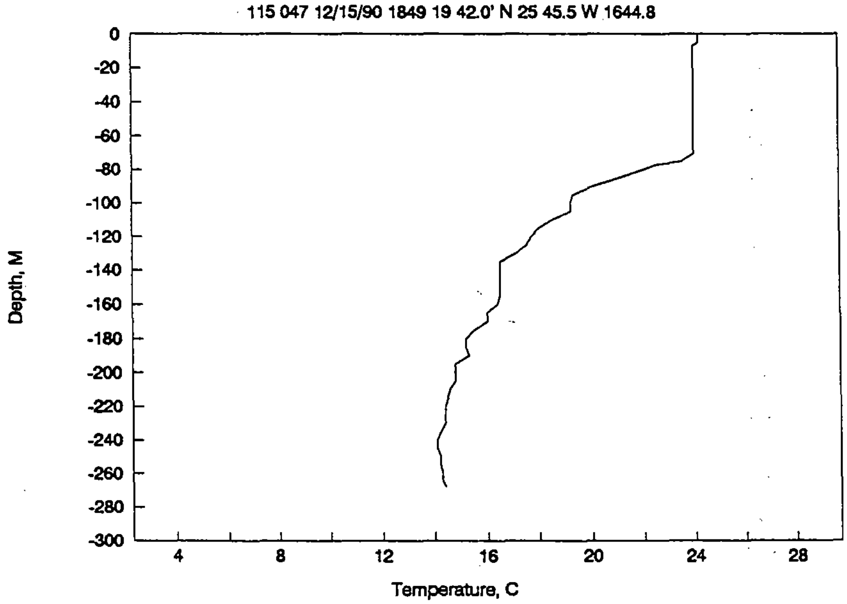
MBT-046

115 046 12/15/90 0832 19 57.2' N 24 47.2' W 1607.8



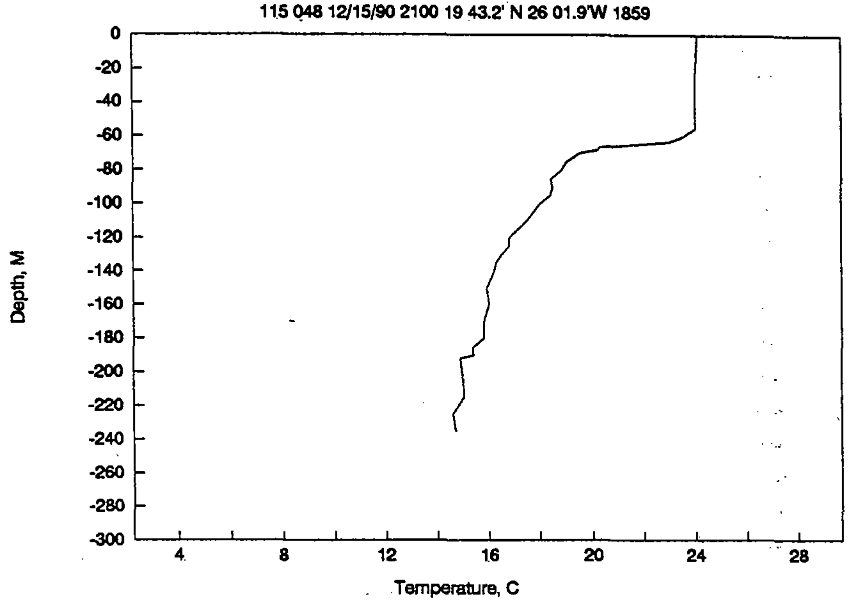
MBT-047

115 047 12/15/90 1849 19 42.0' N 25 45.5 W 1644.8



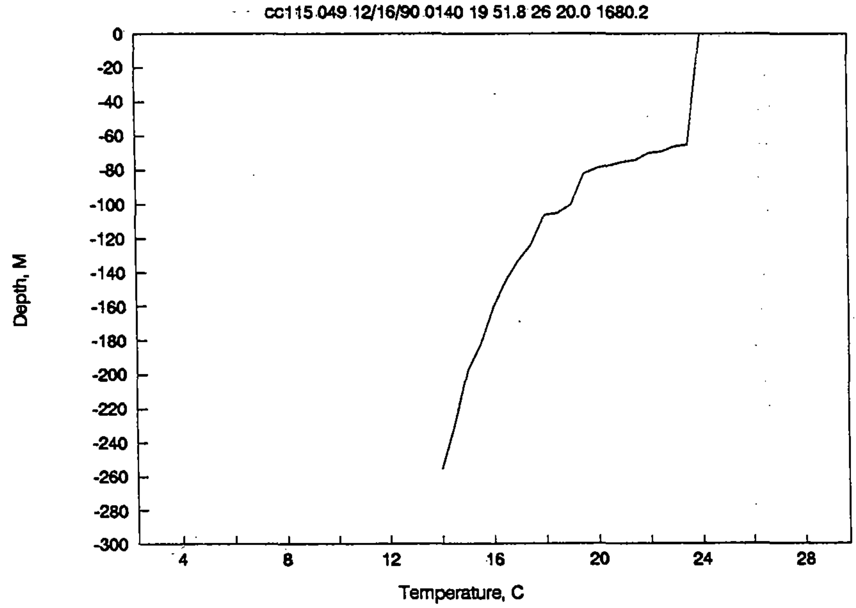
MBT-048

115 048 12/15/90 2100 19 43.2' N 26 01.9'W 1859



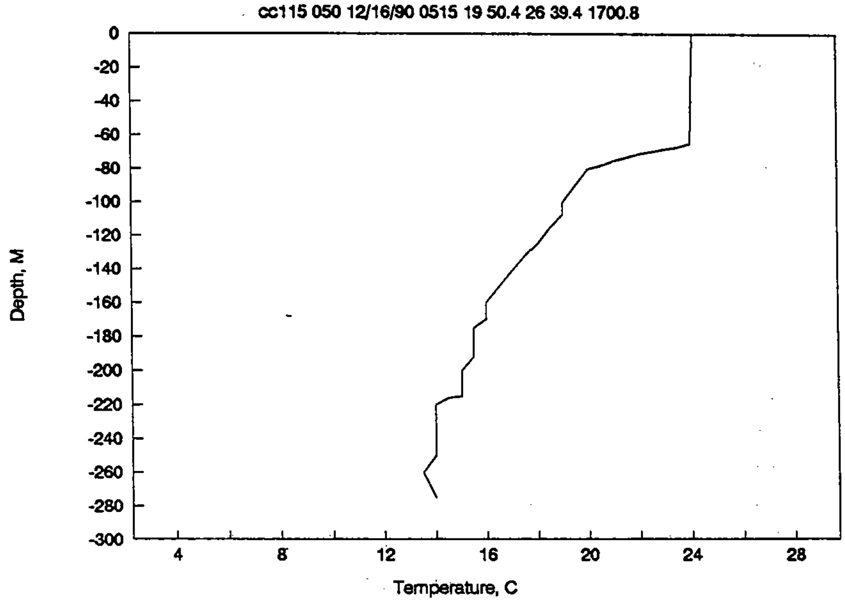
MBT-049

cc115 049 12/16/90 0140 19 51.8 26 20.0 1680.2



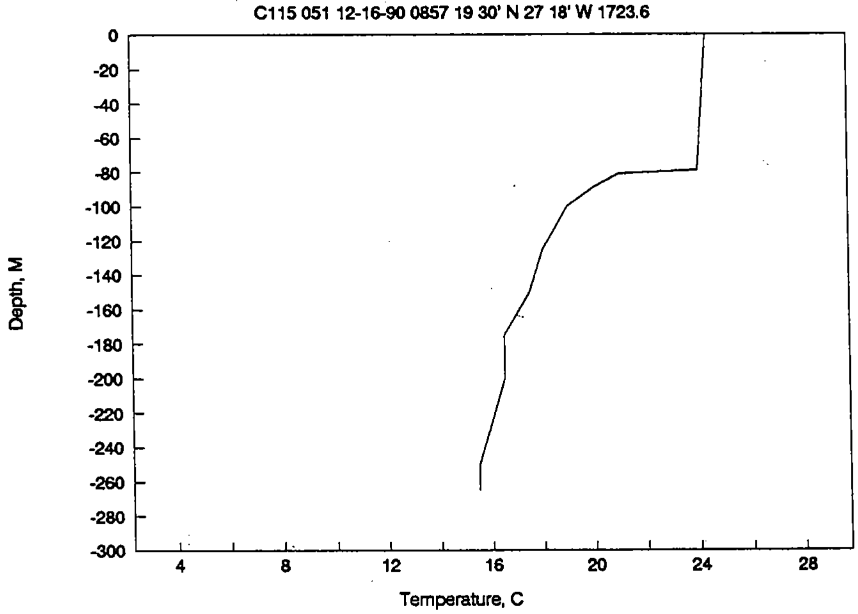
MBT-050

cc115 050 12/16/90 0515 19 50.4 26 39.4 1700.8



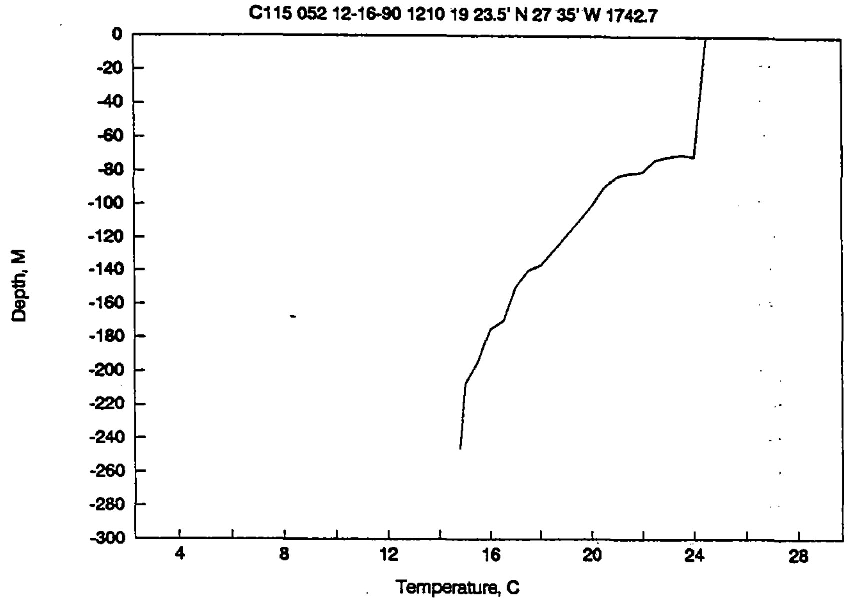
MBT-051

C115 051 12-16-90 0857 19 30' N 27 18' W 1723.6



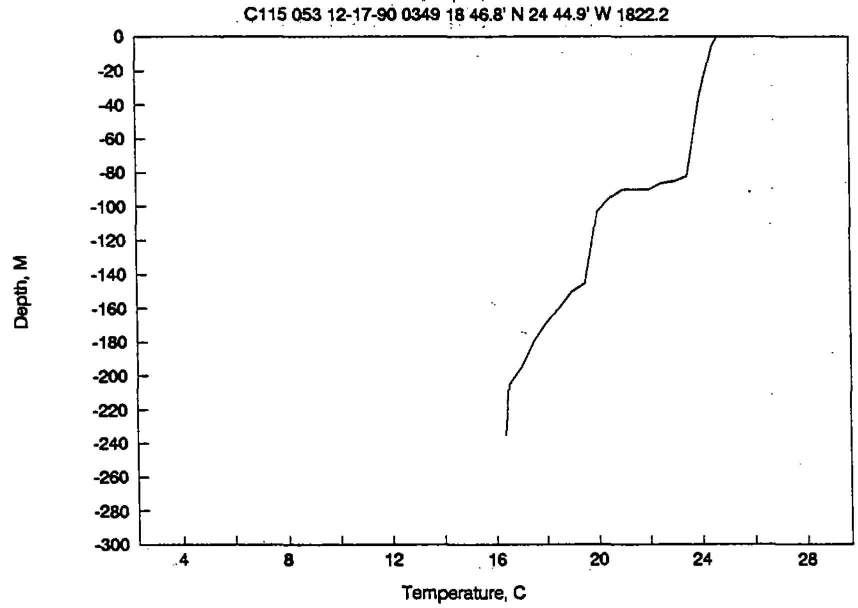
MBT-052

C115 052 12-16-90 1210 19 23.5' N 27 35' W 1742.7



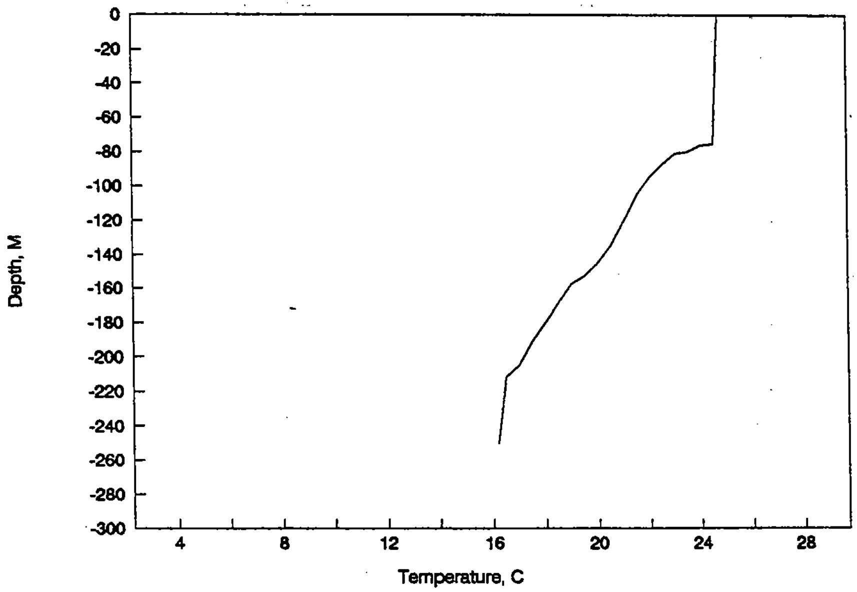
MBT-053

C115 053 12-17-90 0349 18 46.8' N 24 44.9' W 1822.2



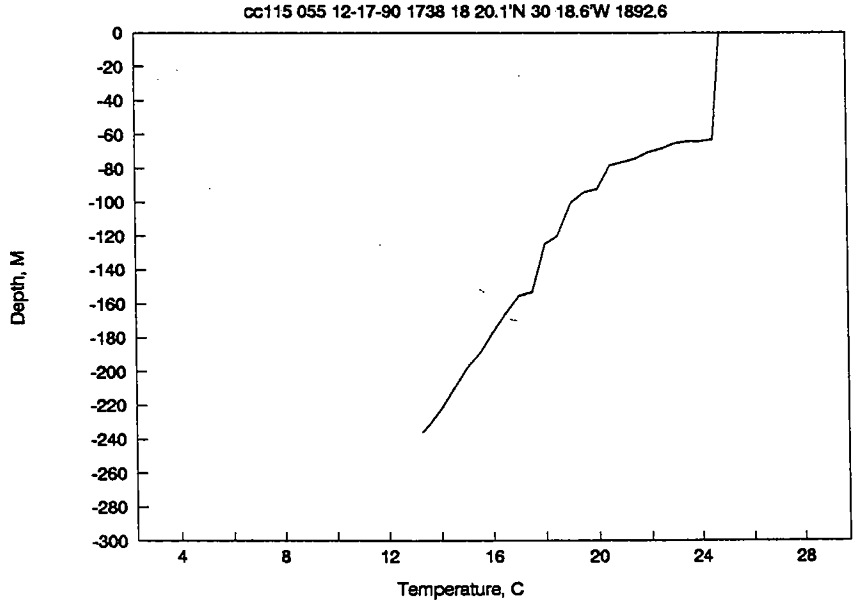
MBT-054

cc115 54 12-17-90 0727 18 36.5'N 29 19.6'W 1843.7



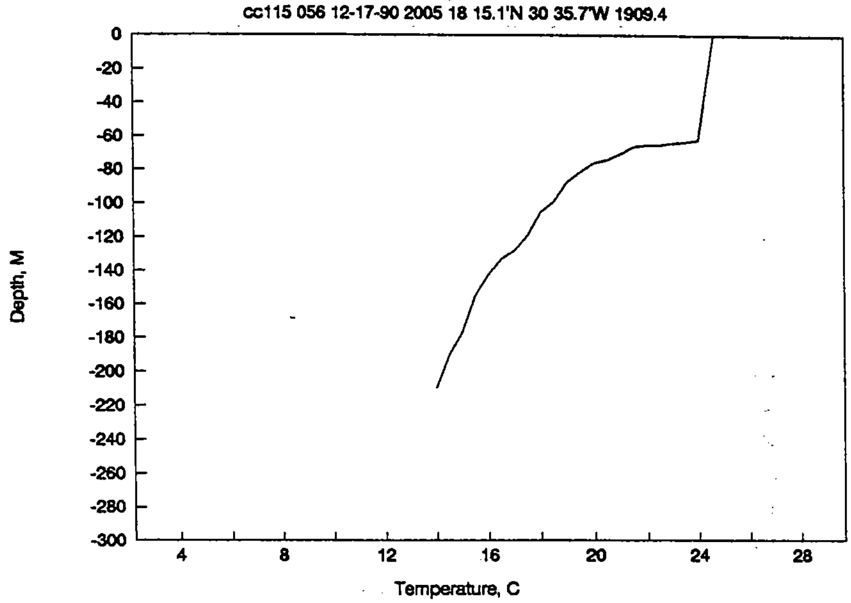
MBT-055

cc115 055 12-17-90 1738 18 20.1'N 30 18.6'W 1892.6



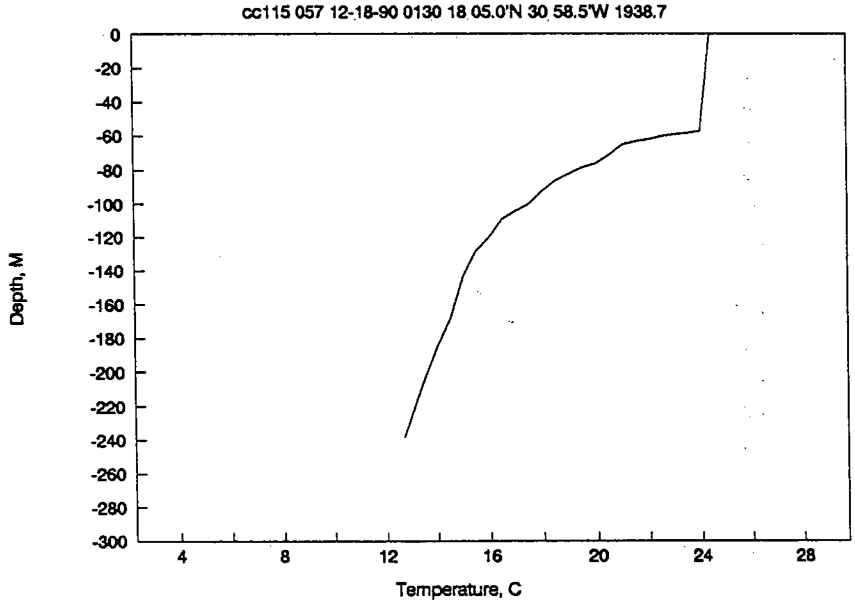
MBT-056

cc115 056 12-17-90 2005 18 15.1'N 30 35.7'W 1909.4



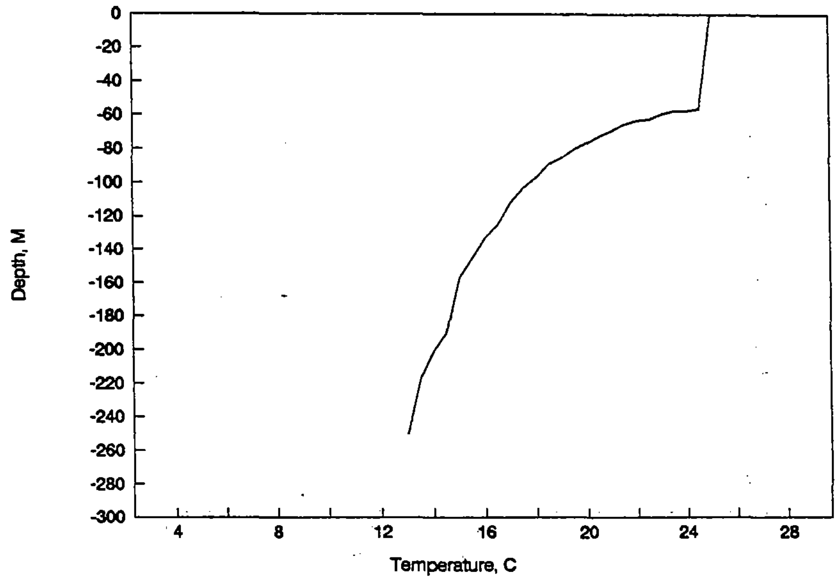
MBT-057

cc115 057 12-18-90 0130 18 05.0'N 30 58.5'W 1938.7



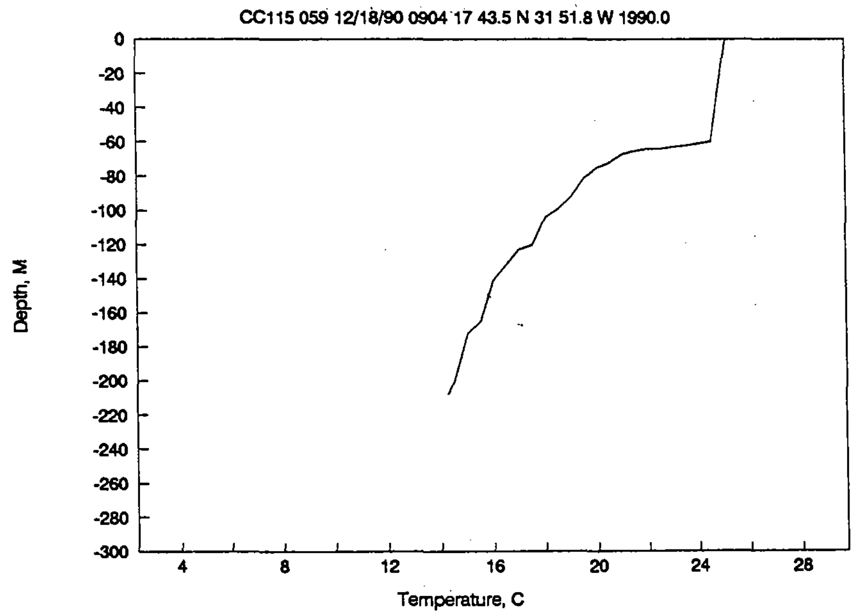
MBT-058

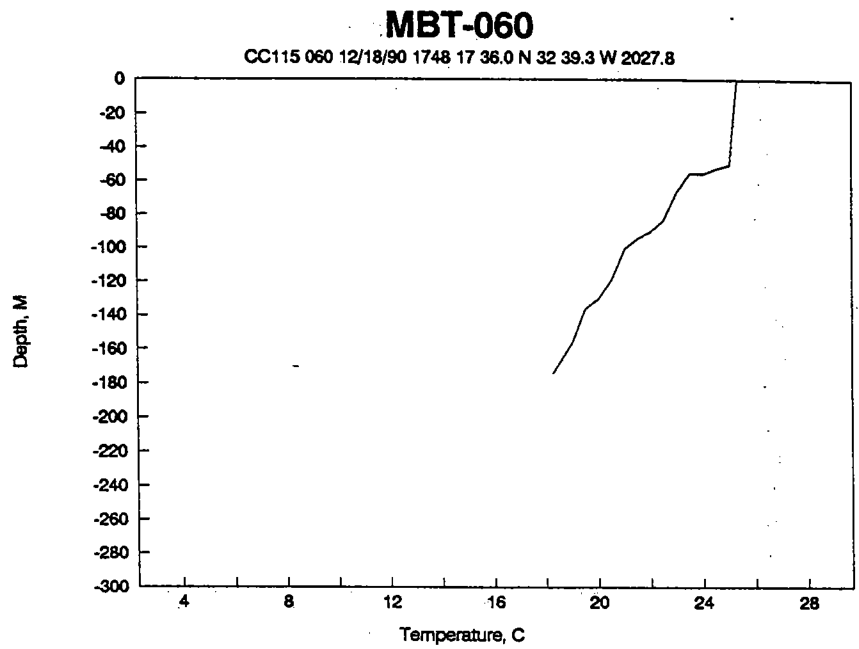
cc115 058 12-18-90 0500 18 01.9'N 31 25.1'W 1961.4

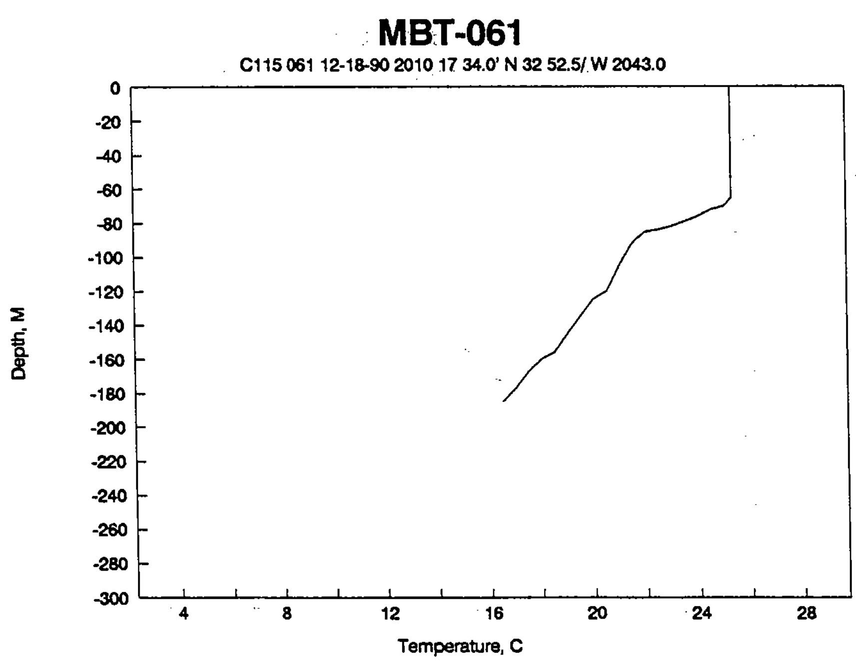


MBT-059

CC115 059 12/18/90 0904 17 43.5 N 31 51.8 W 1990.0

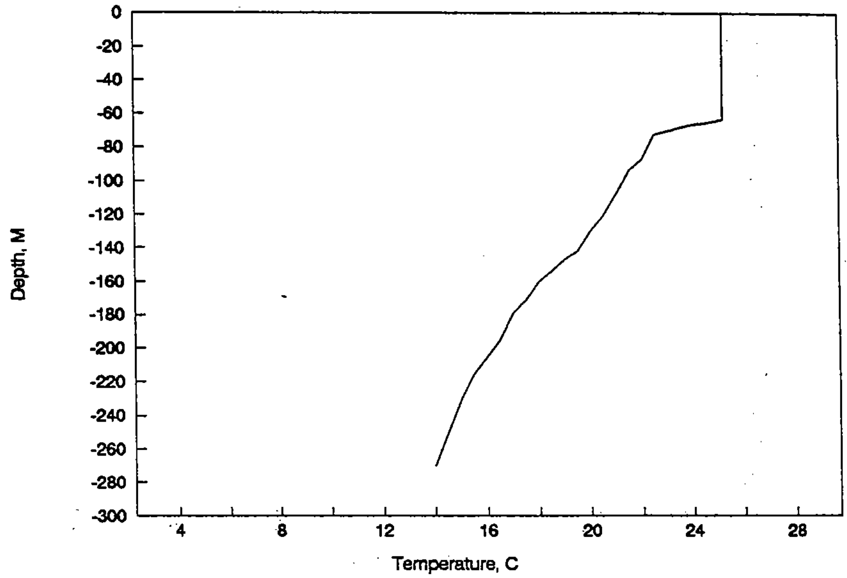



MBT-060
CC115 060 12/18/90 1748 17 36.0 N 32 39.3 W 2027.8
Depth, M
Temperature, C
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
4
8
12
16
20
24
28


MBT-061
C115 061 12-18-90 2010 17 34.0' N 32 52.5/ W 2043.0
Depth, M
Temperature, C
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
4
8
12
16
20
24
28

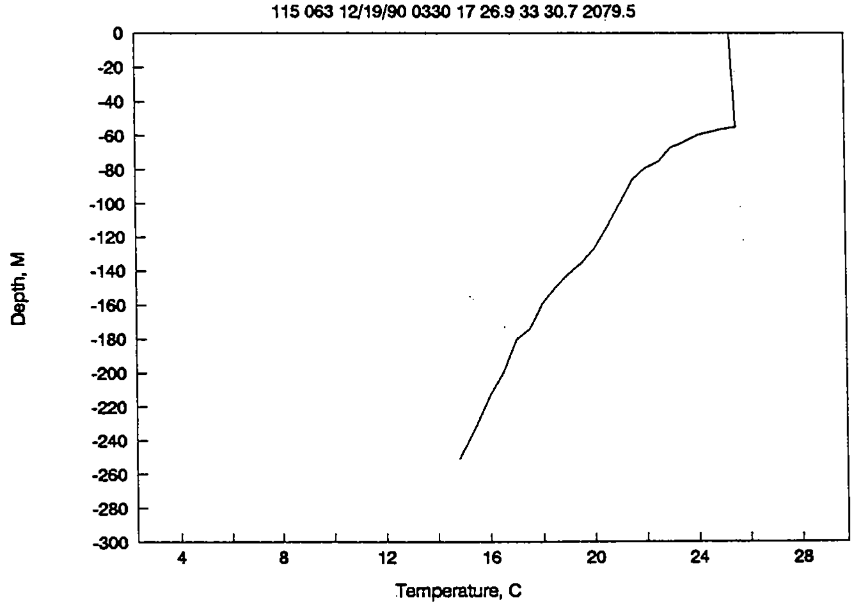
MBT-062

CC115 62 12/18/90 2250 17 31.0 N 33 11.0 W 2058.4



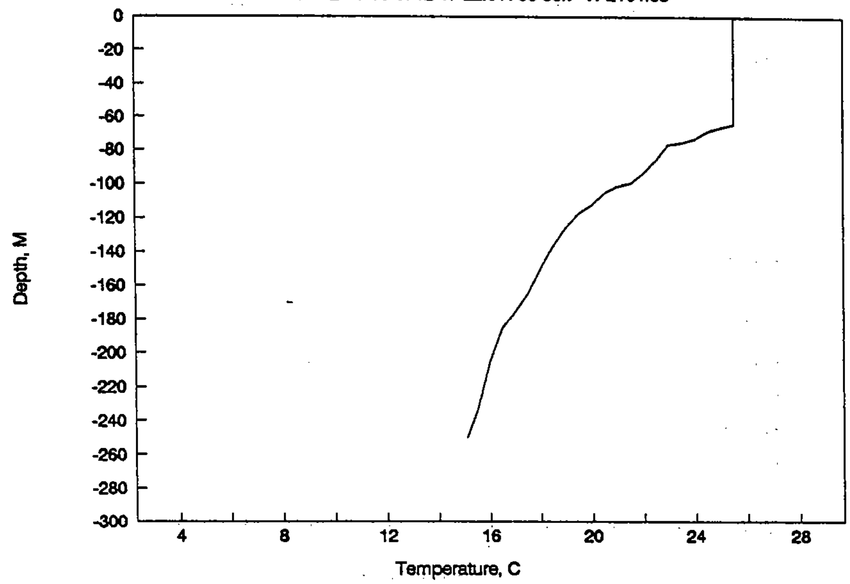
MBT-063

115 063 12/19/90 0330 17 26.9 33 30.7 2079.5



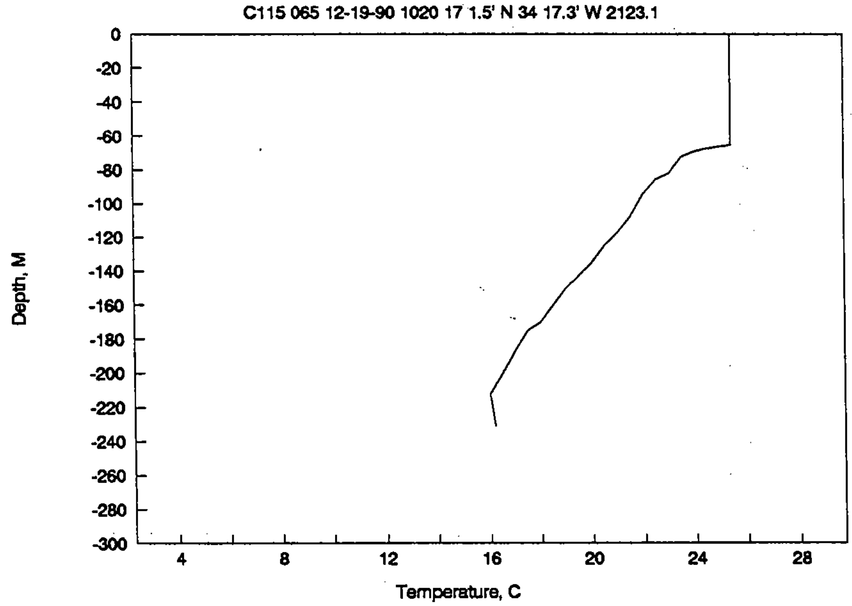
MBT-064

C115 064 12-19-90 0712 17 22.6'N 33 53.7' W 2101.55



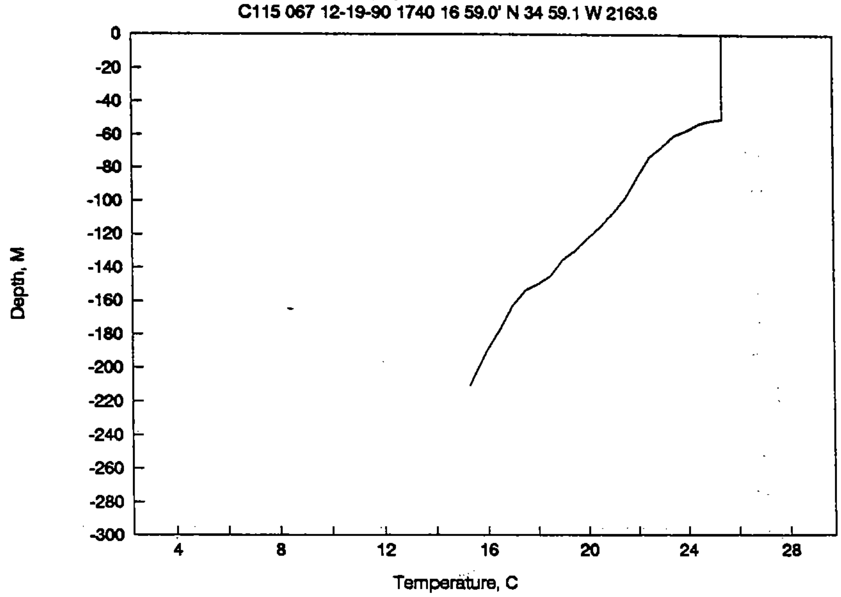
MBT-065

C115 065 12-19-90 1020 17 1.5' N 34 17.3' W 2123.1



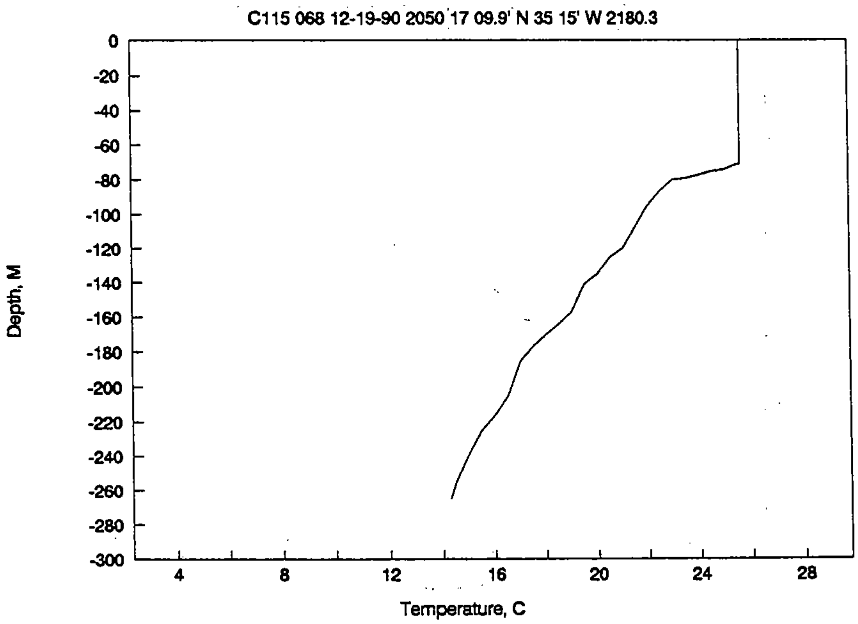
MBT-067

C115 067 12-19-90 1740 16 59.0' N 34 59.1 W 2163.6



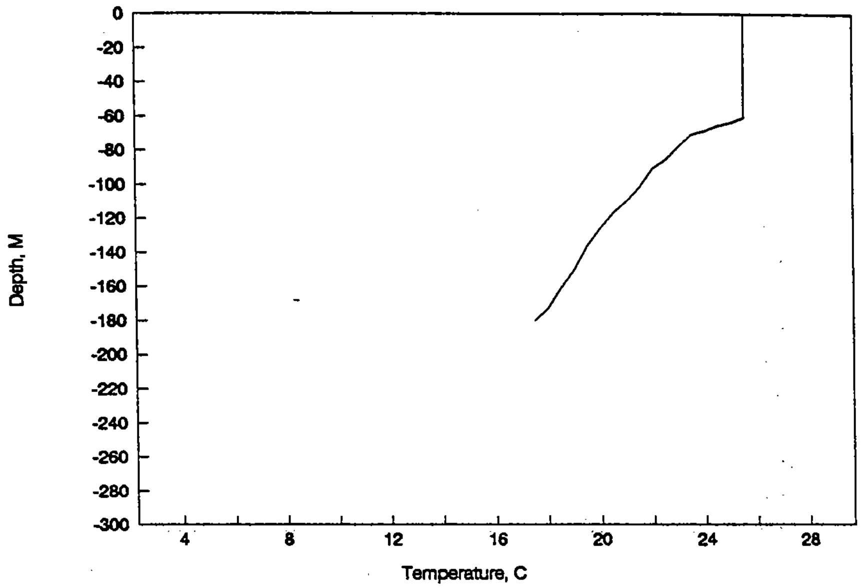
MBT-068

C115 068 12-19-90 2050 17 09.9' N 35 15' W 2180.3



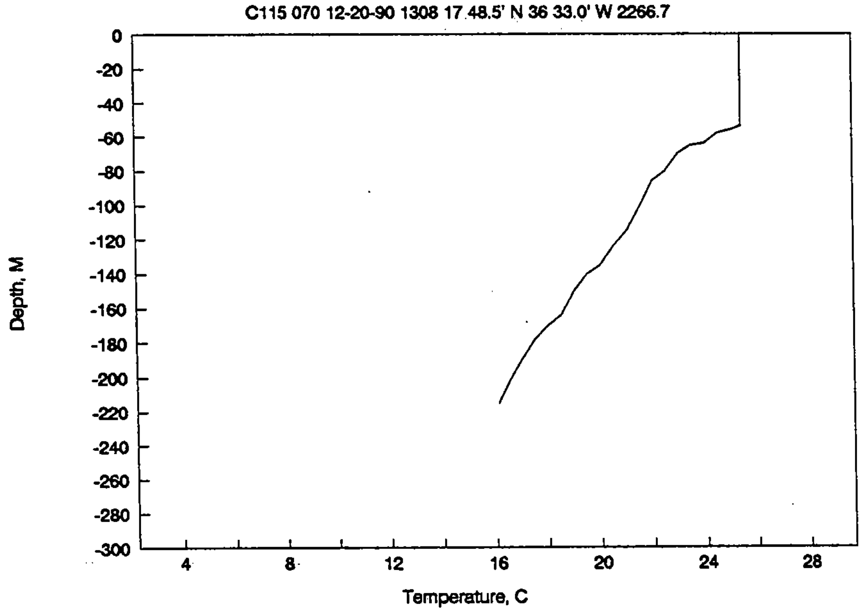
MBT-069

C115 069 12-20-90 0625 17 21.2' N 35 52.1' W 2222.6



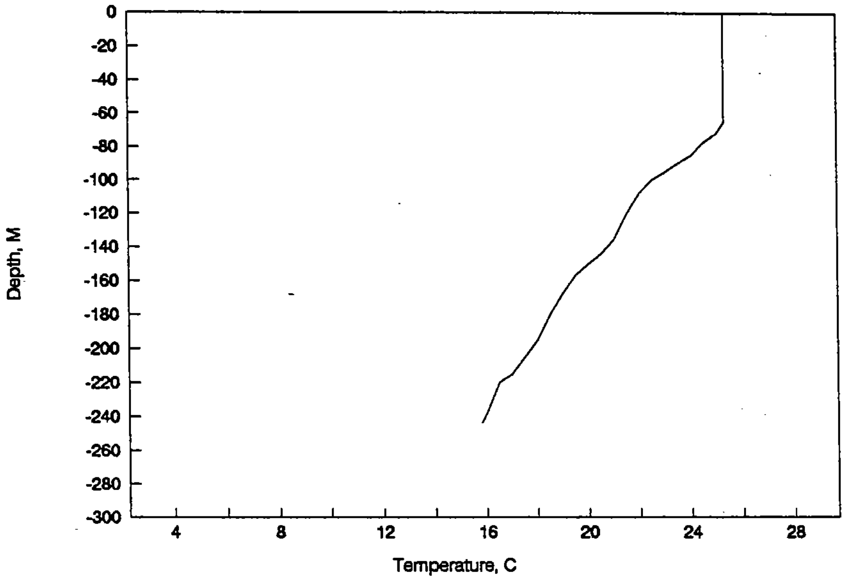
MBT-070

C115 070 12-20-90 1308 17 48.5' N 36 33.0' W 2266.7



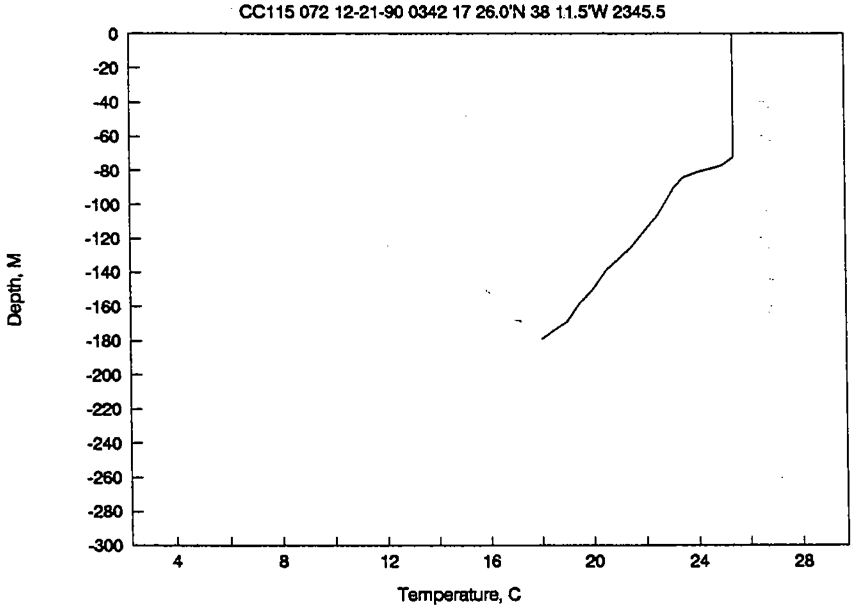
MBT-071

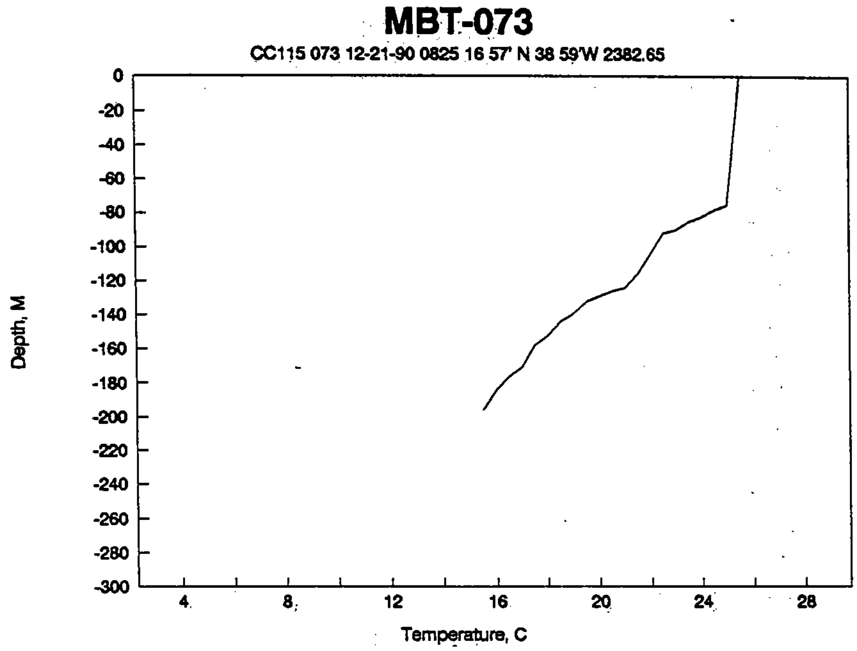
115 071 12/20/90 1757 17 39.9 37 28.4 2302.0



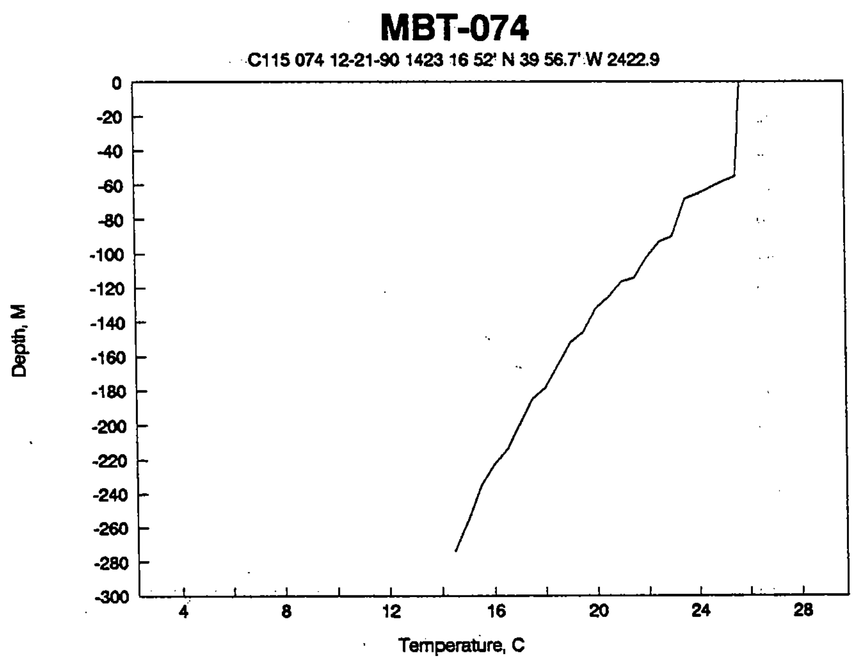
MBT-072

CC115 072 12-21-90 0342 17 26.0'N 38 11.5'W 2345.5



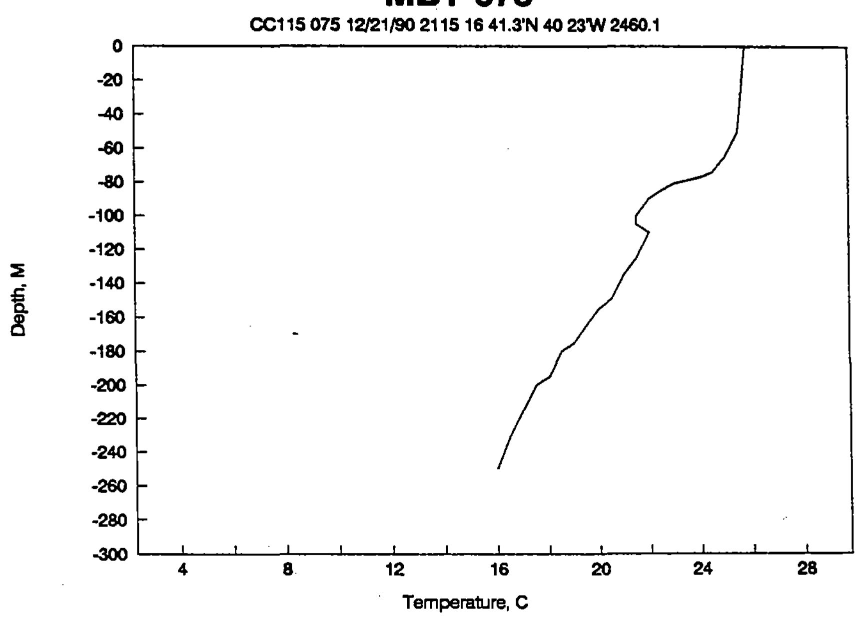


MBT-073
CC115 073 12-21-90 0825 16 57' N 38 59'W 2382.65
Depth, M
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
4
8
12
16
20
24
28
Temperature, C

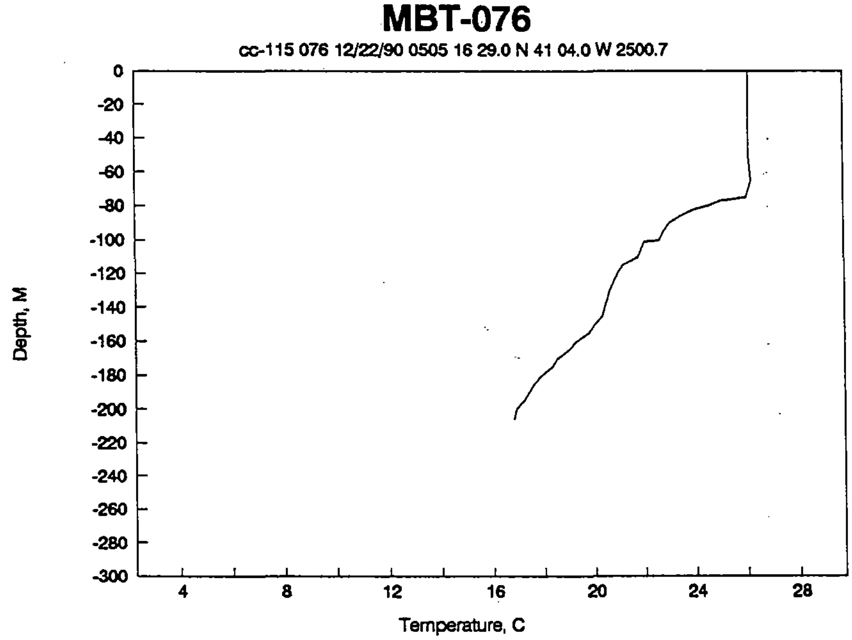


MBT-074
C115 074 12-21-90 1423 16 52' N 39 56.7' W 2422.9
Depth, M
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
4
8
12
16
20
24
28
Temperature, C

MBT-075

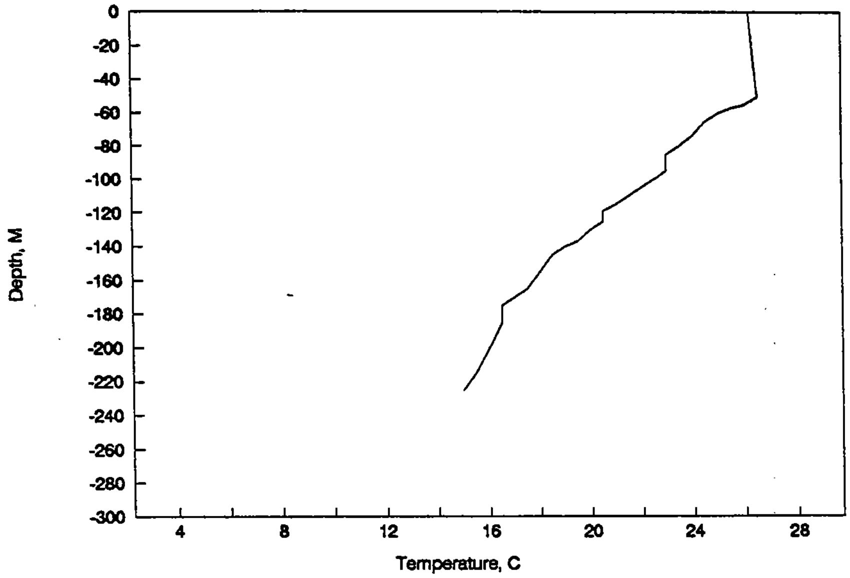


MBT-076



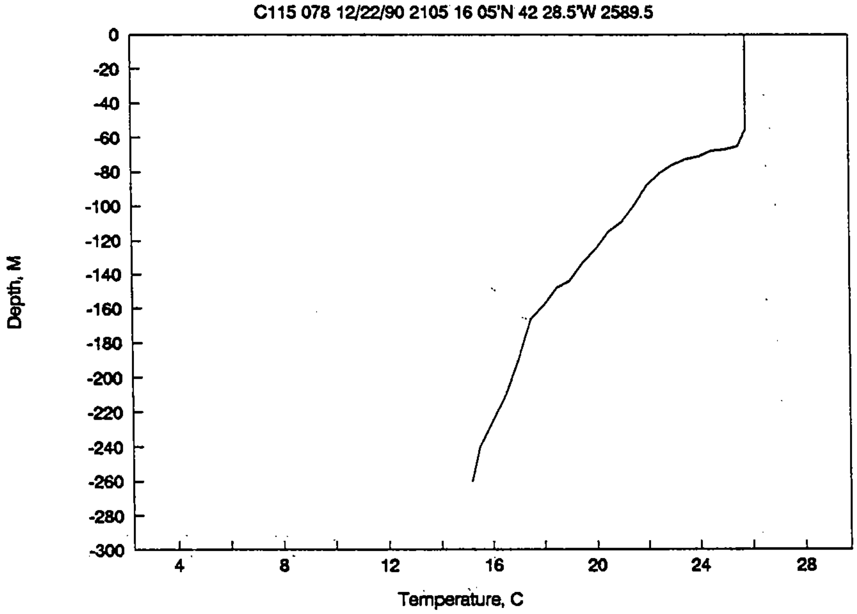
MBT-077

115 077 12/22/90 1322 16 08.5'N 41 44.8'W 2542.1



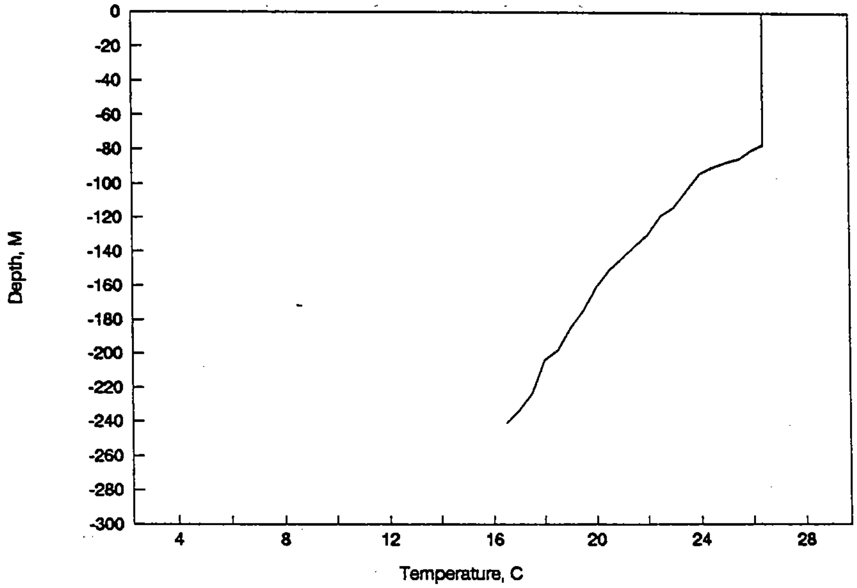
MBT-078

C115 078 12/22/90 2105 16 05'N 42 28.5'W 2589.5



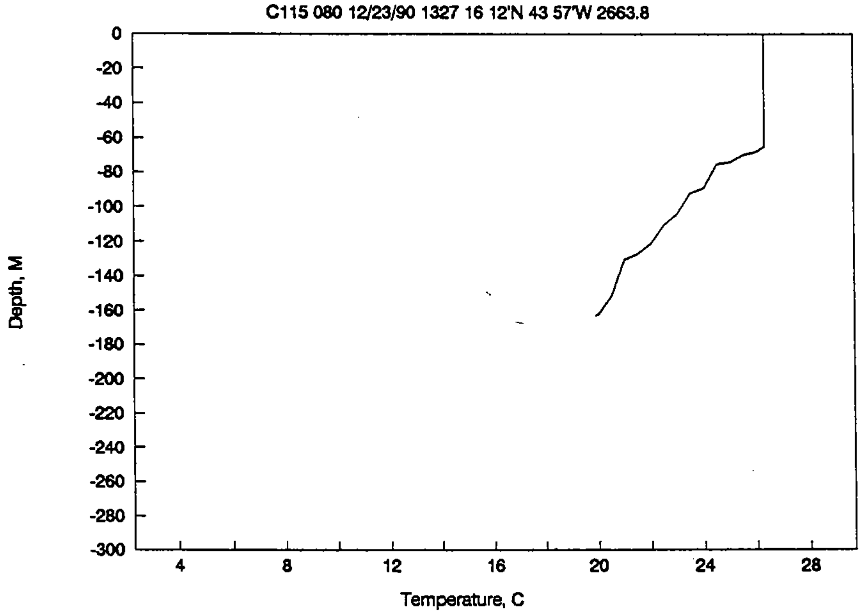
MBT-079

C115 079 12/23/90 0855 15 49.5'N 43 36'W 2628.2



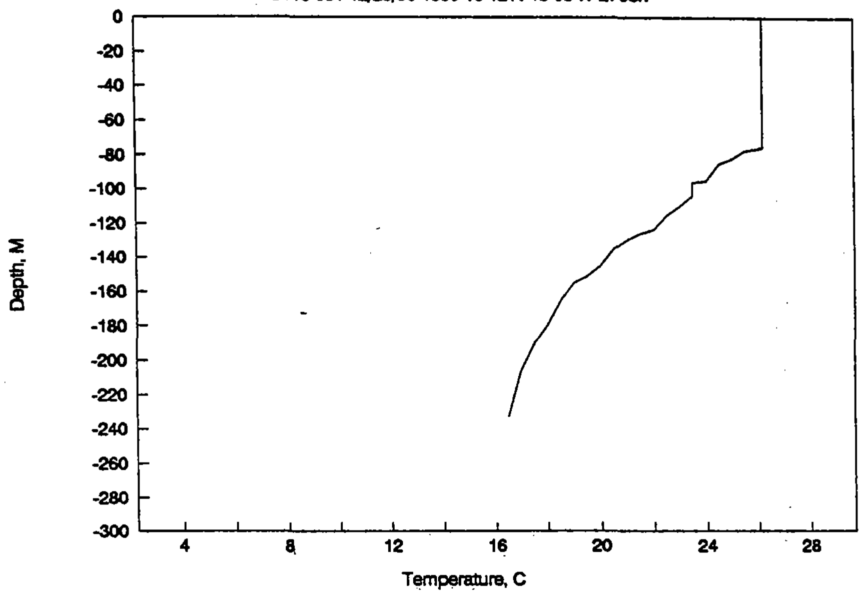
MBT-080

C115 080 12/23/90 1327 16 12'N 43 57'W 2663.8



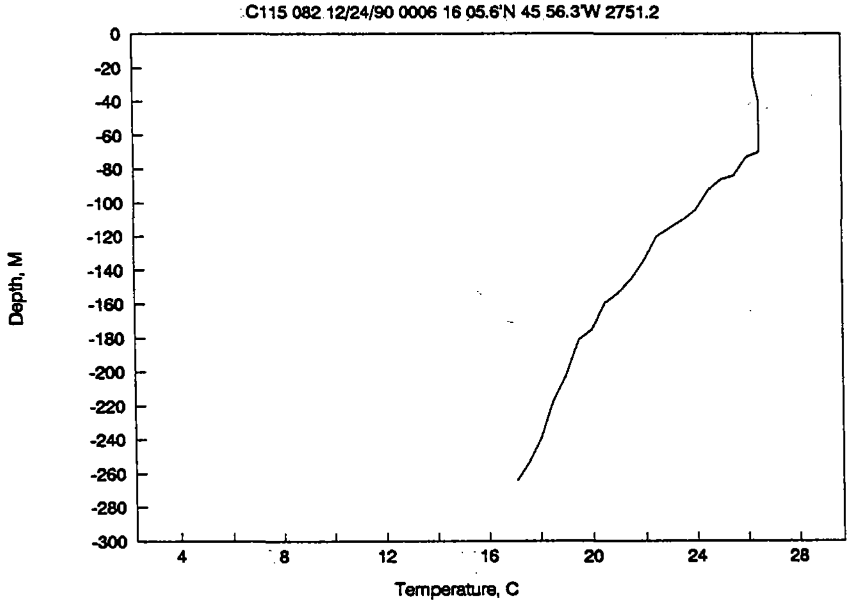
MBT-081

C115 081 12/23/90 1830 16 12'N 45 05'W 2708.7



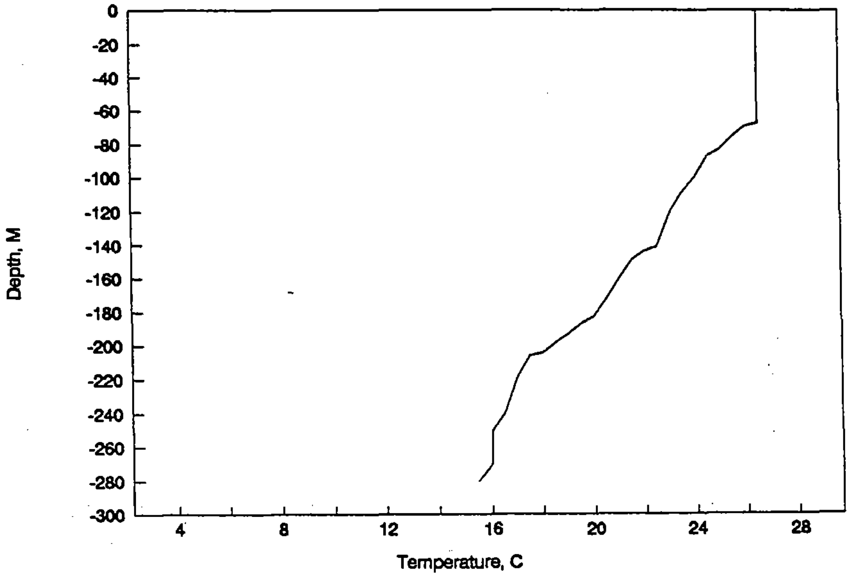
MBT-082

C115 082 12/24/90 0006 16 05.6'N 45 56.3'W 2751.2



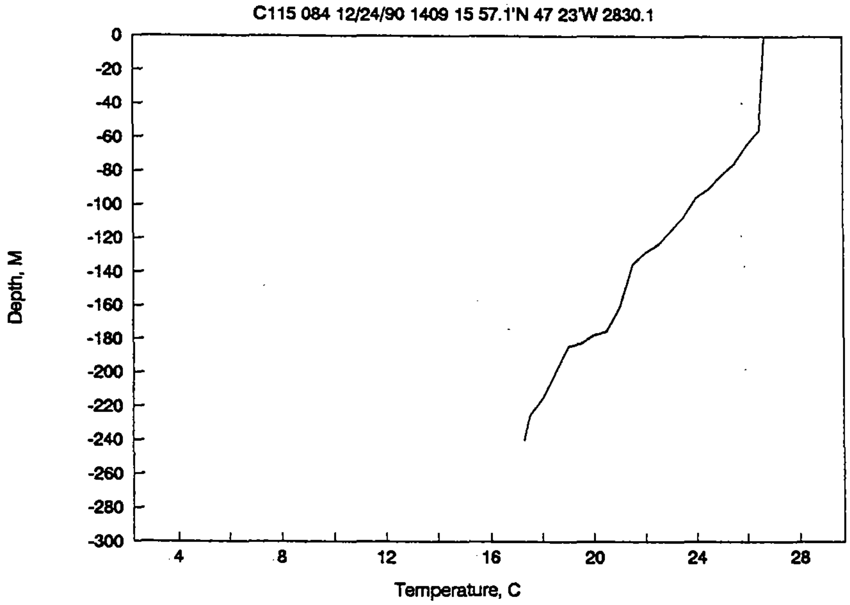
MBT-083

C115 083 12/24/90 0553 16 05.3'N 46 38'W 2790.1



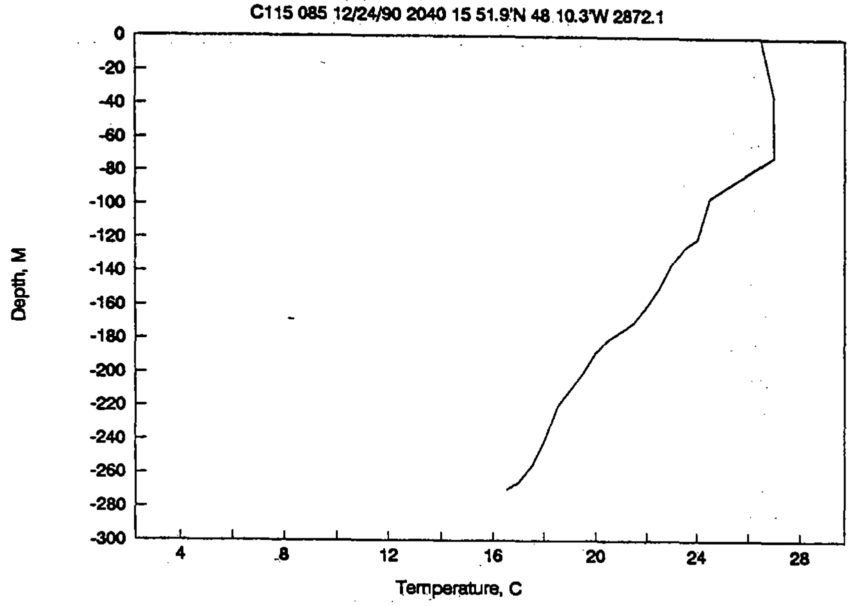
MBT-084

C115 084 12/24/90 1409 15 57.1'N 47 23'W 2830.1



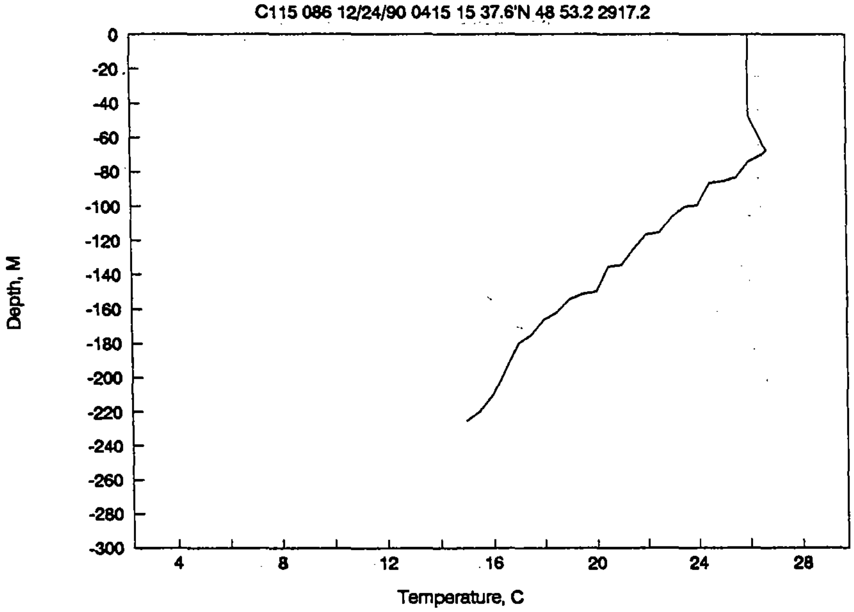
MBT-085

C115 085 12/24/90 2040 15 51.9'N 48 10.3'W 2872.1

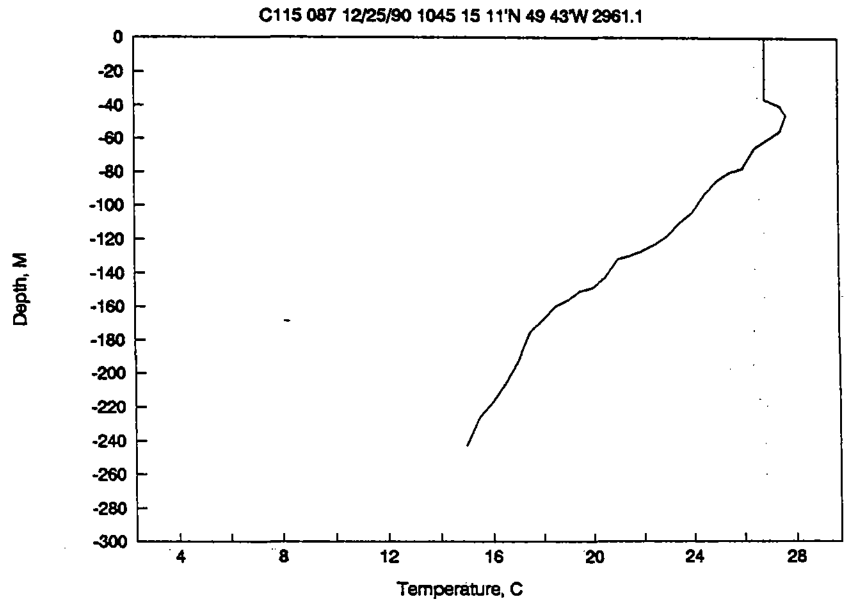


MBT-086

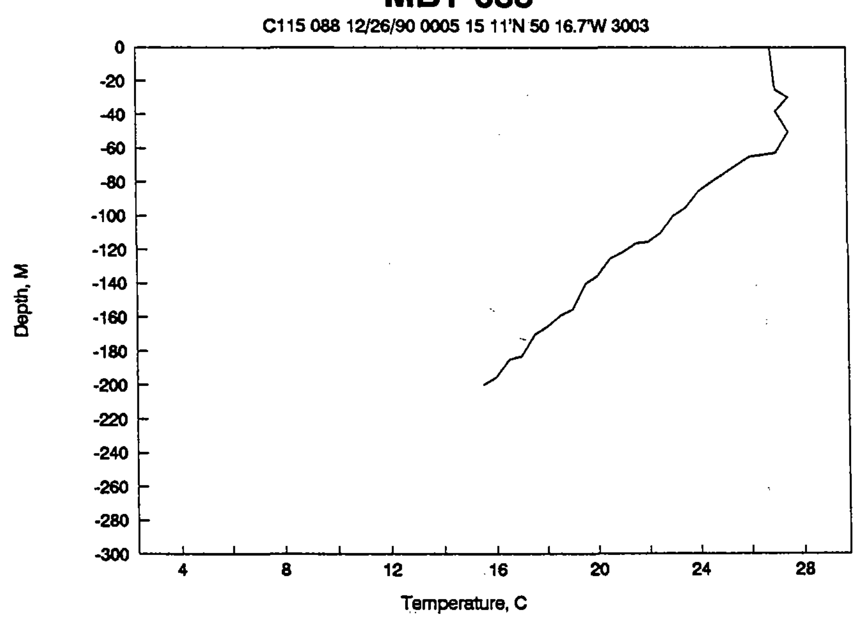
C115 086 12/24/90 0415 15 37.6'N 48 53.2 2917.2



MBT-087

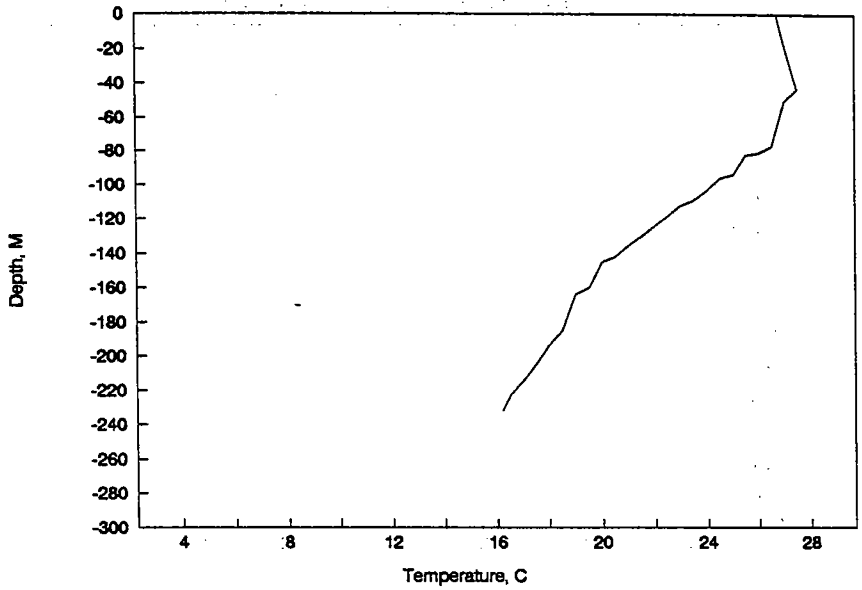


MBT-088



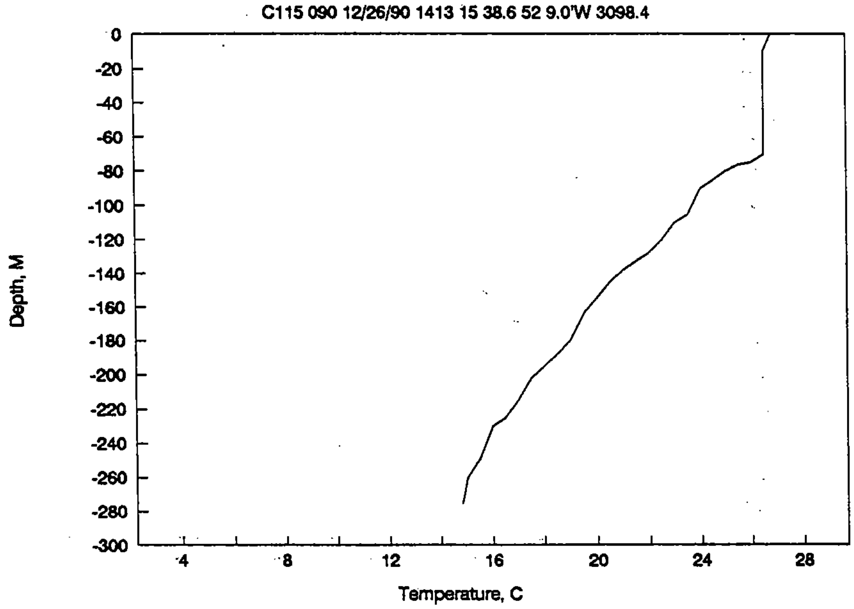
MBT-089

C115 089 12/26/90 0500 15 29.2'N 50 52.2'W 3042.2



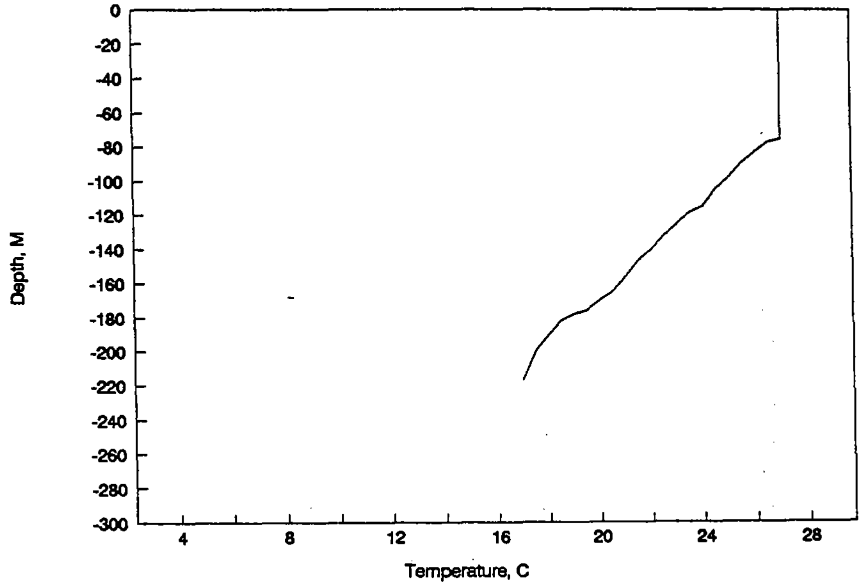
MBT-090

C115 090 12/26/90 1413 15 38.6 52 9.0'W 3098.4



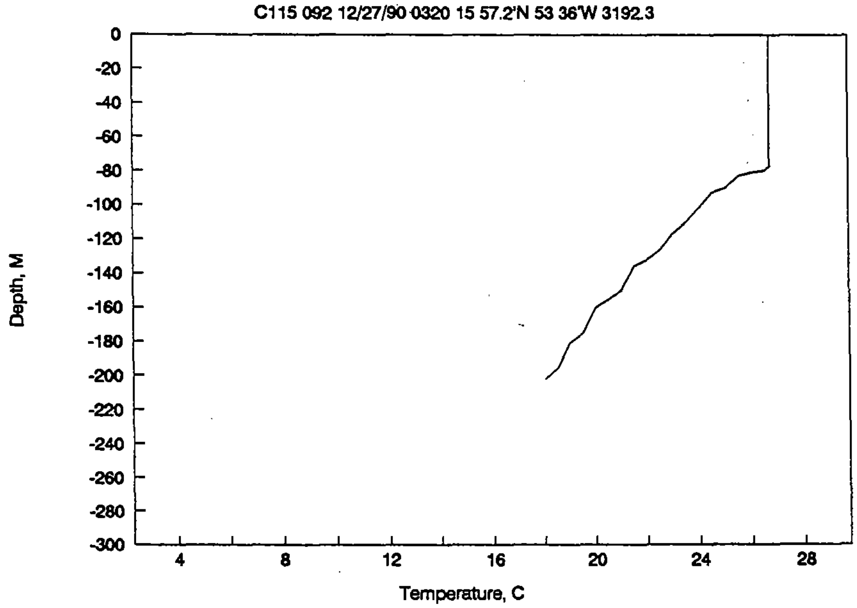
MBT-091

C115 091 12/26/90 2030 15 58'N 52 50'W 3143.6



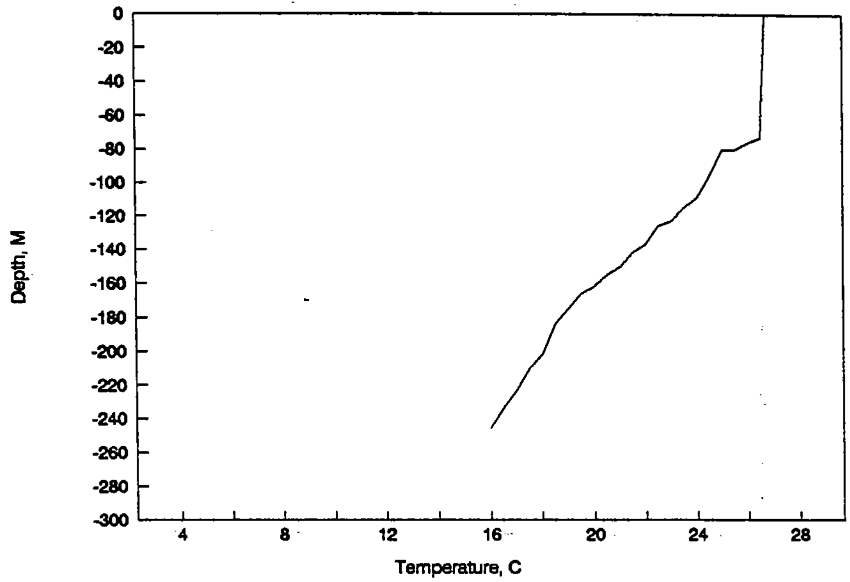
MBT-092

C115 092 12/27/90 0320 15 57.2'N 53 36'W 3192.3



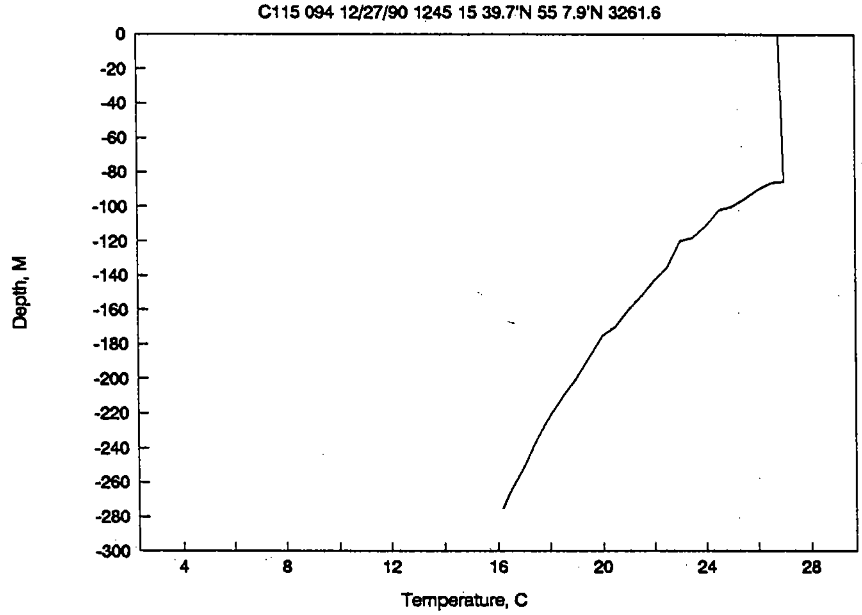
MBT-093

C115 093 12/27/90 0710 15 45.9'N 54 06.1'W 3221.5



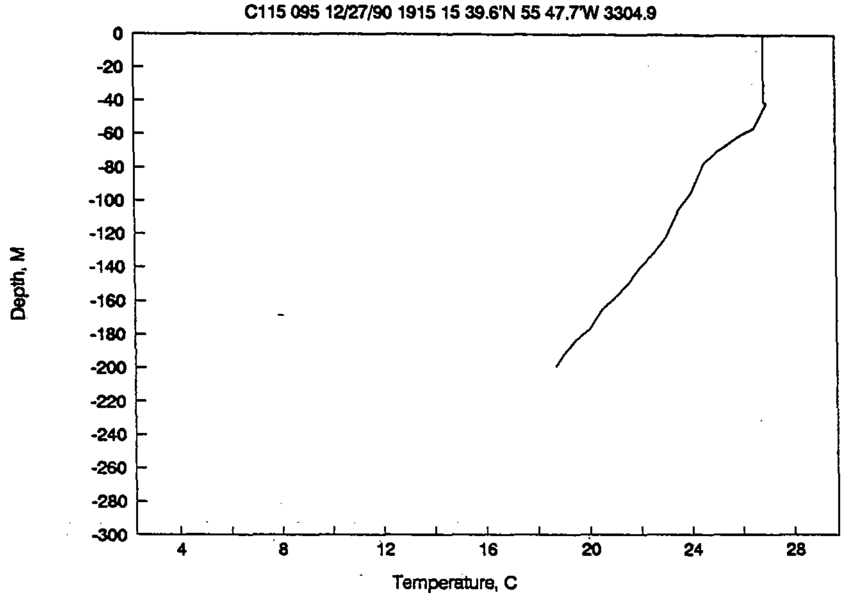
MBT-094

C115 094 12/27/90 1245 15 39.7'N 55 7.9'N 3261.6



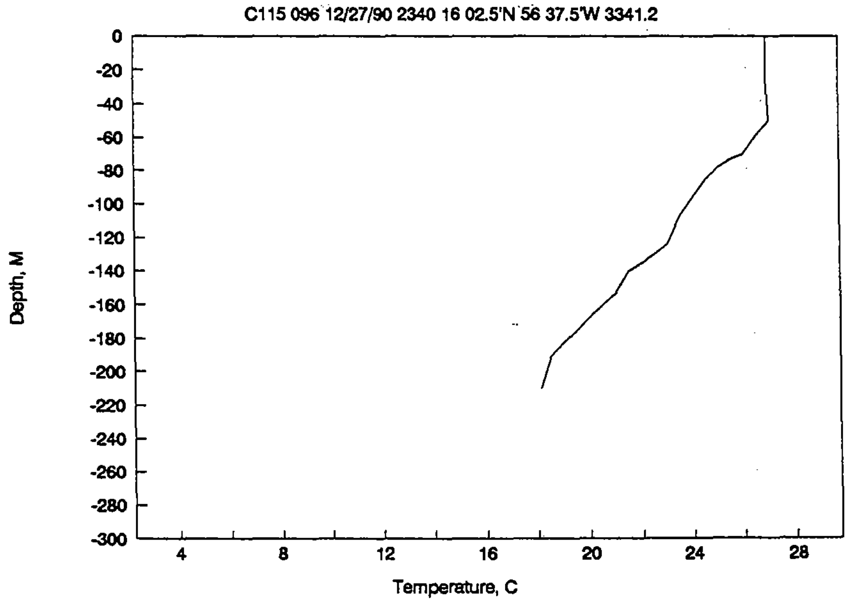
MBT-095

C115 095 12/27/90 1915 15 39.6'N 55 47.7'W 3304.9



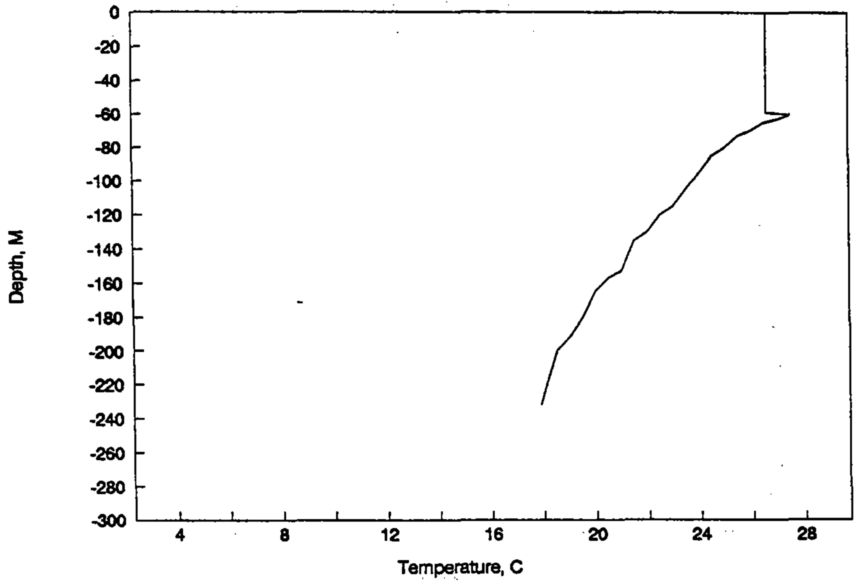
MBT-096

C115 096 12/27/90 2340 16 02.5'N 56 37.5'W 3341.2



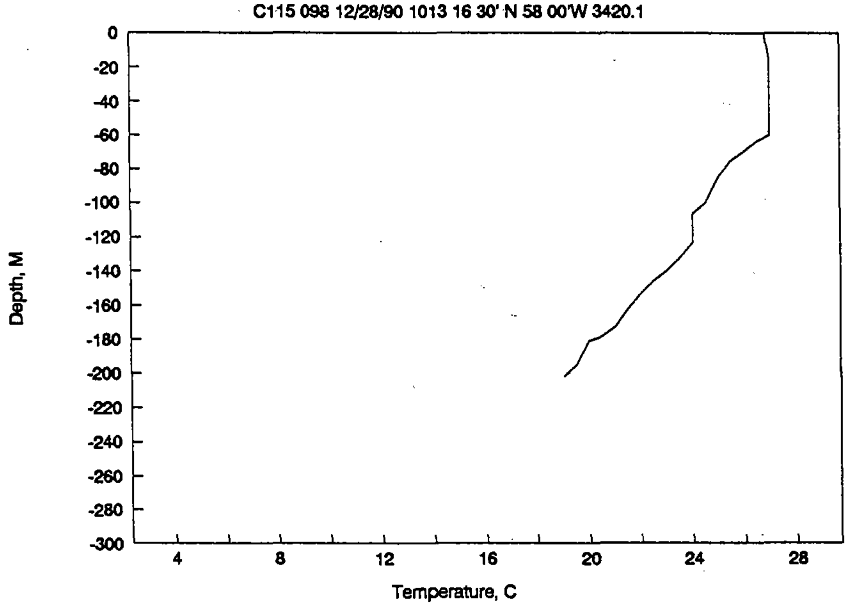
MBT-097

C115 097 12/28/90 0440 16 16.4'N 57 18.7'W 3380.6



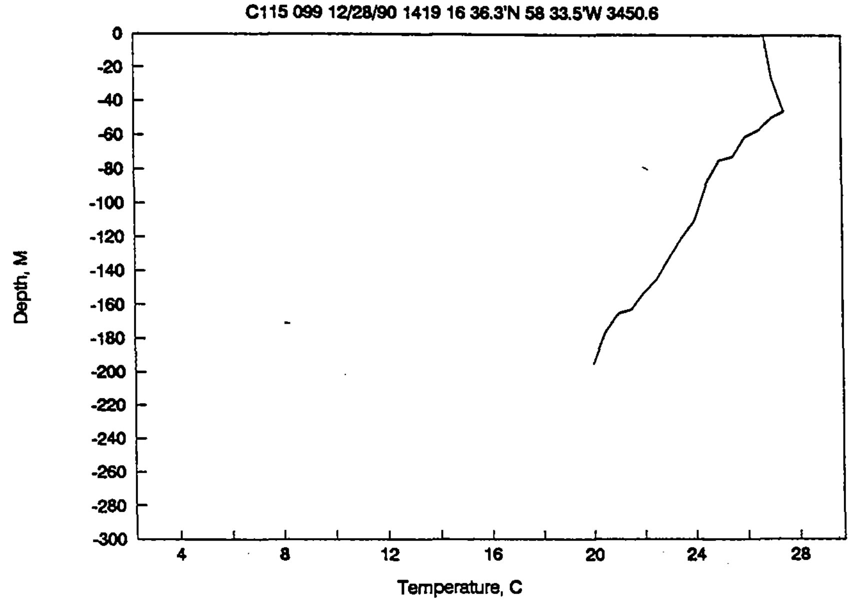
MBT-098

C115 098 12/28/90 1013 16 30' N 58 00'W 3420.1



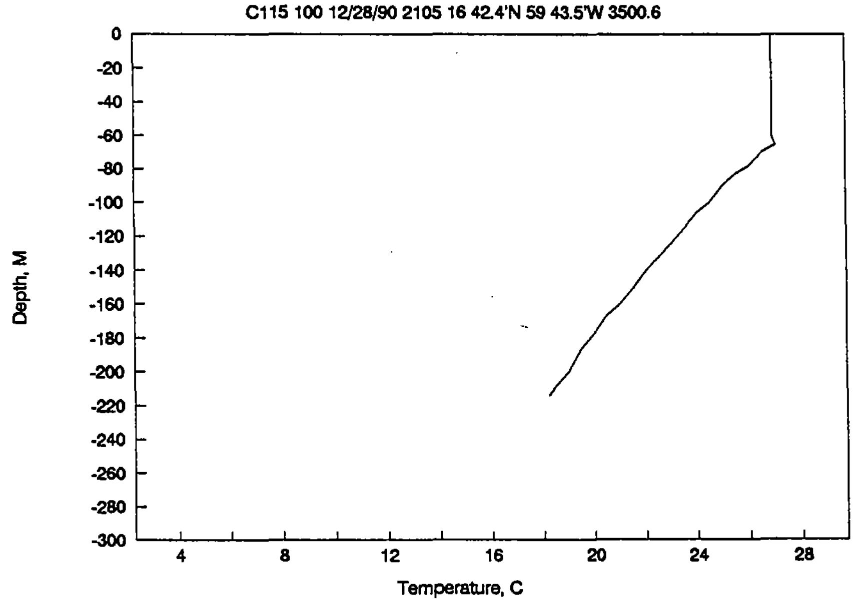
MBT-099

C115 099 12/28/90 1419 16 36.3'N 58 33.5'W 3450.6



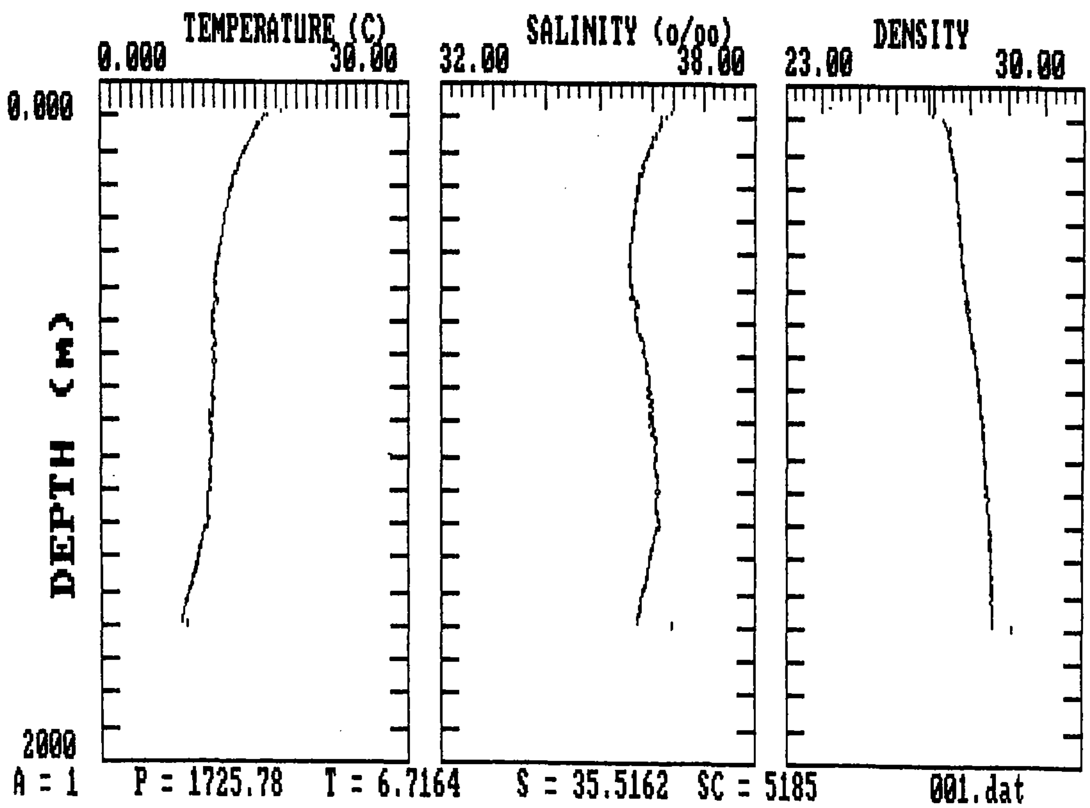
MBT-100

C115 100 12/28/90 2105 16 42.4'N 59 43.5'W 3500.6



Appendix D

CTD DATA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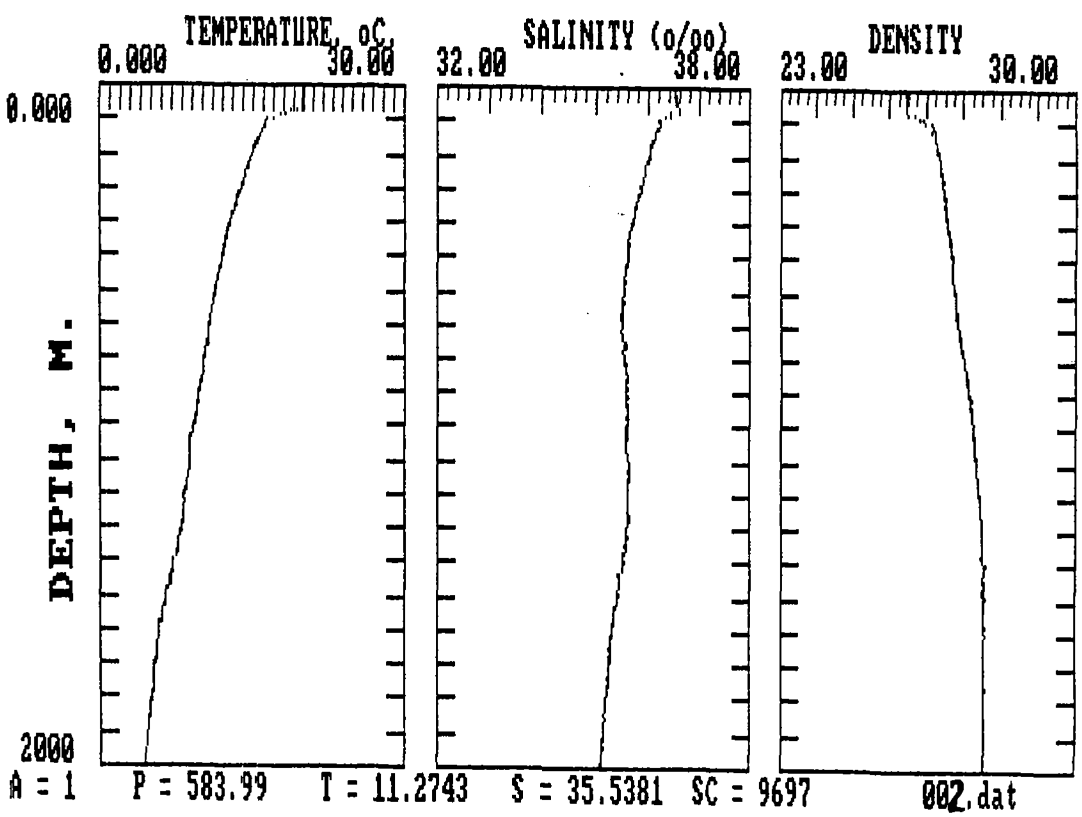
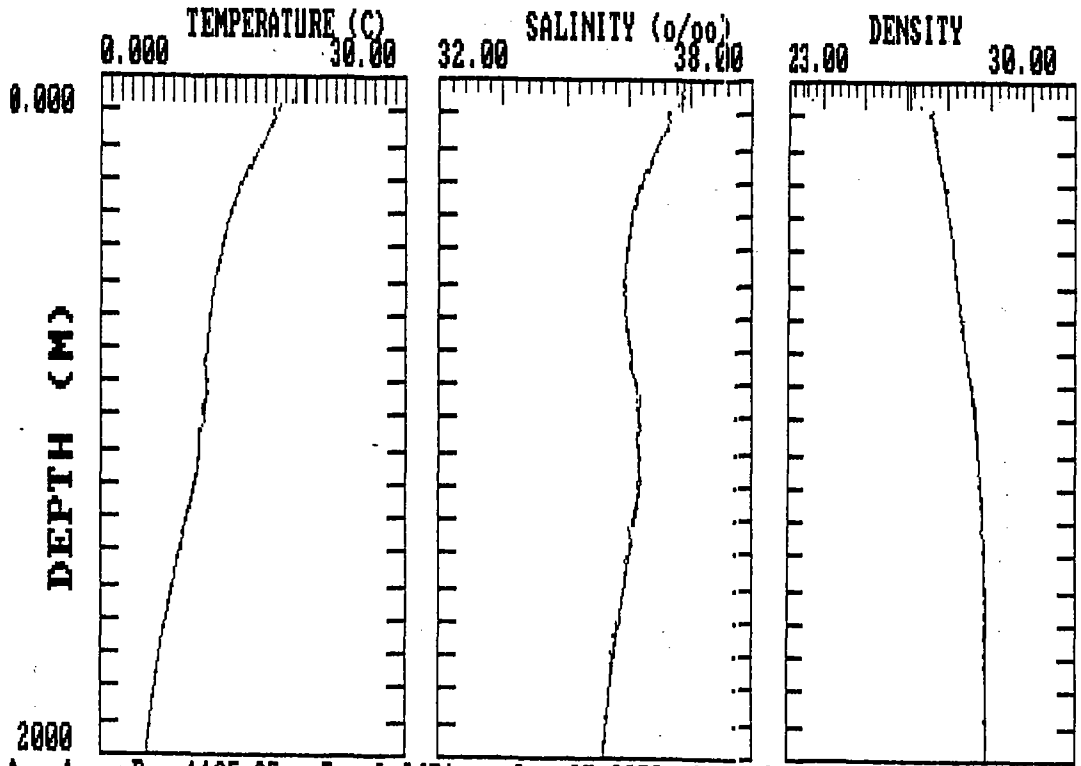
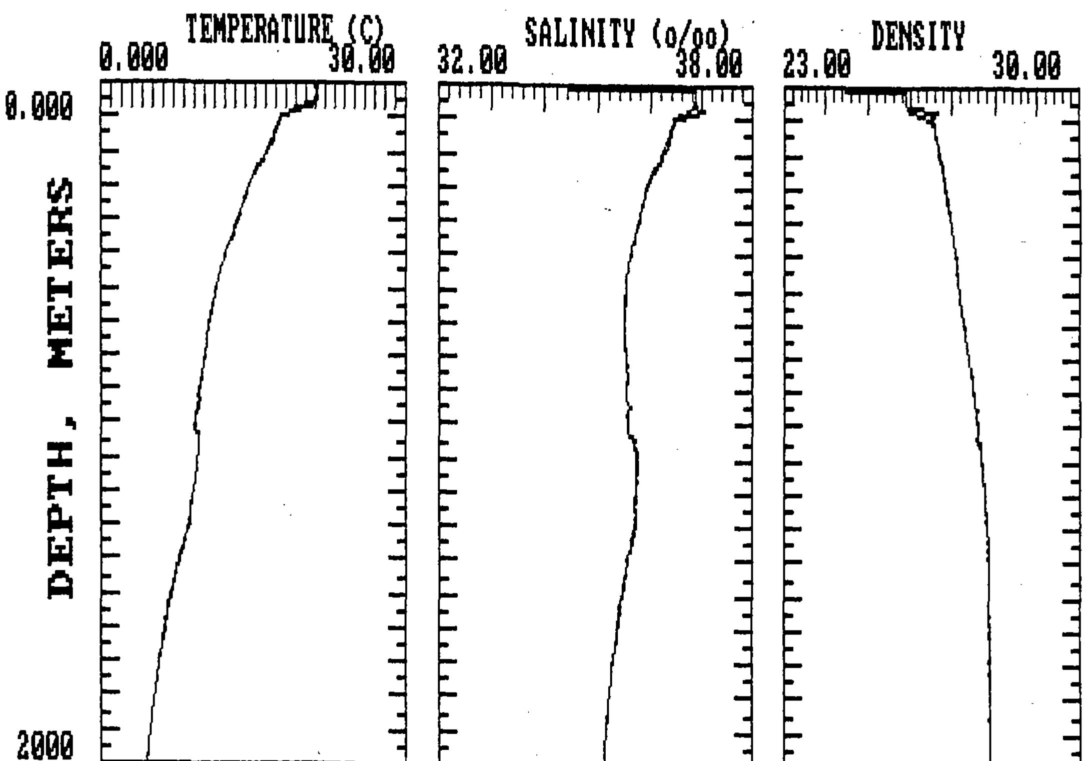
0.000
30.00
SALINITY (o/oo)
32.00
38.00
DENSITY
23.00
30.00
0.000
DEPTH (m)
2000
A = 1
P = 1725.78
T = 6.7164
S = 35.5162
SC = 5185
001.dat

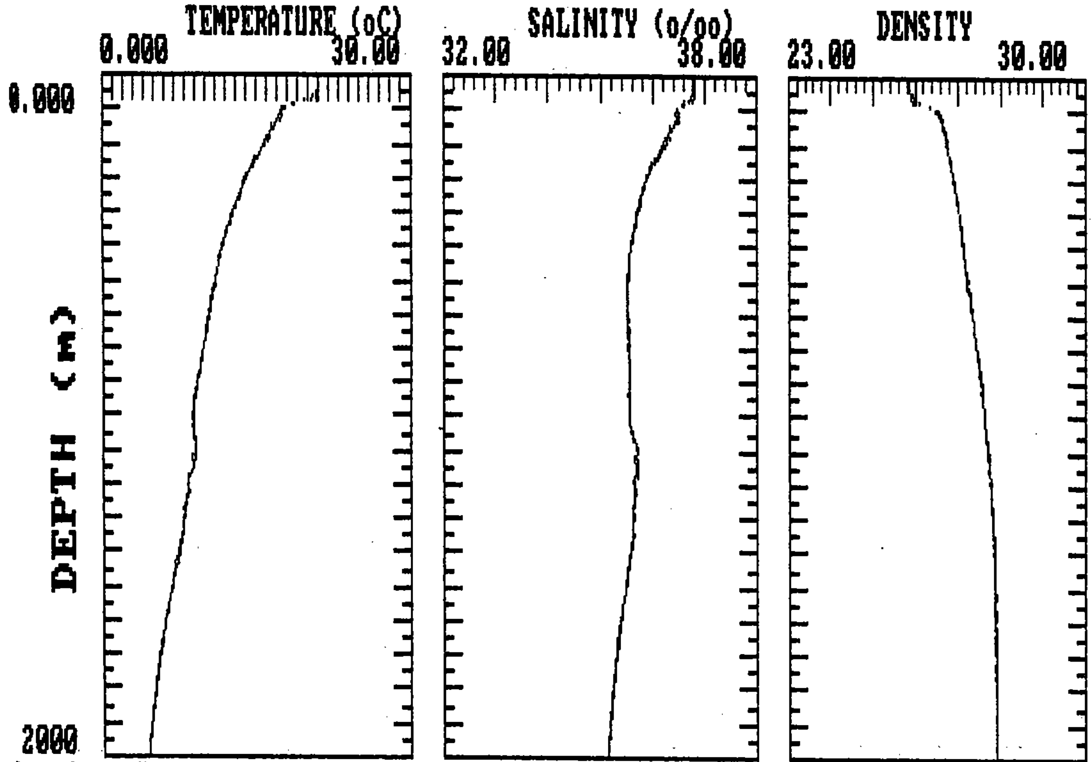

TEMPERATURE, oC.
0.000
30.00
SALINITY (o/oo)
32.00
38.00
DENSITY
23.00
30.00
0.000
DEPTH, M.
2000
A = 1
P = 583.99
T = 11.2743
S = 35.5381
SC = 9697
002.dat



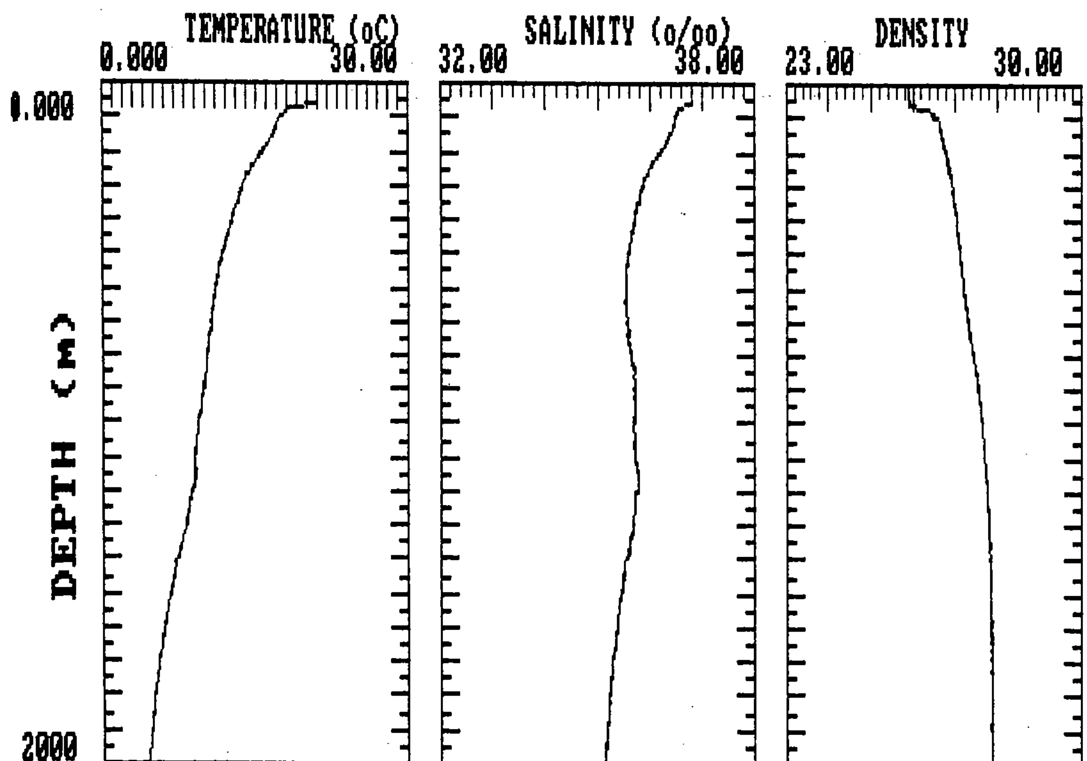
A = 1 P = 1195.85 T = 9.2471 S = 35.8372 SC = 8081 003.dat
C-115-CTD-003 33 53N X 17 14W 3.12.90



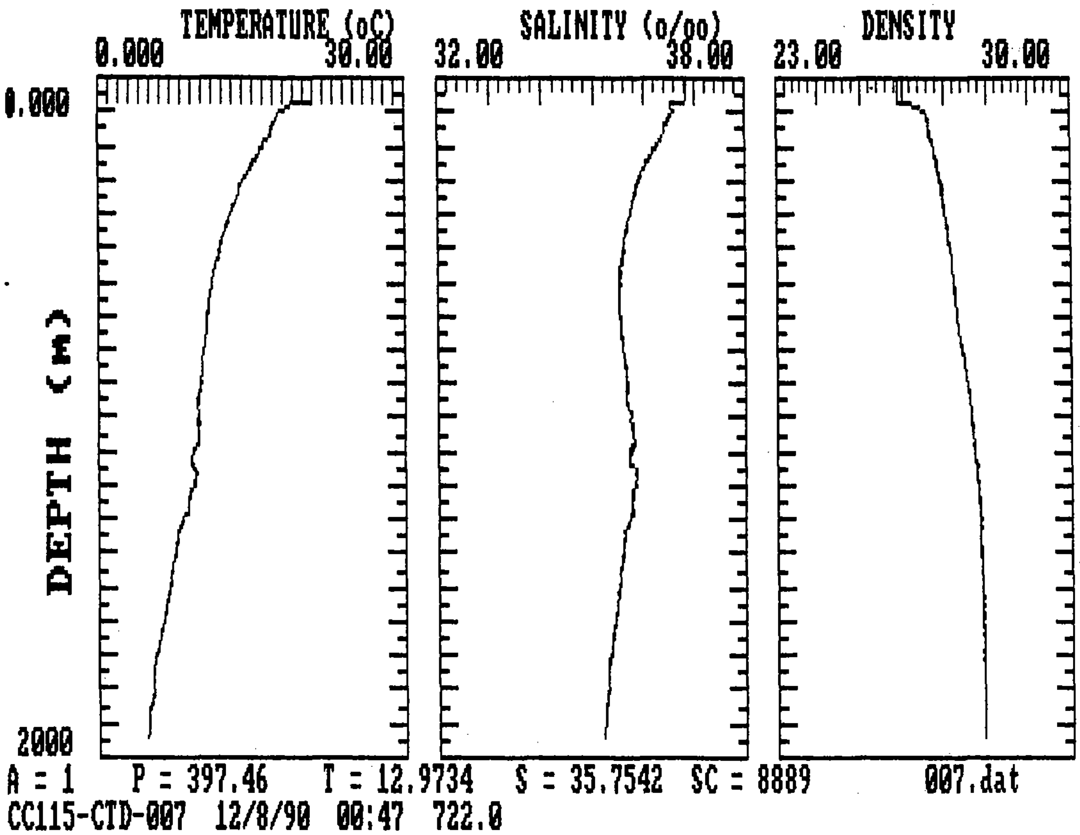
A = 1 P = 876.84 T = 9.6097 S = 35.5780 SC = 7879 004.dat
C115-CTD-004 31 47.0N X 16 30.8W 7 DECEMBER 1990



A = 1 P = 521.23 T = 11.5303 S = 35.5577 SC = 8485 005.dat
CC115-CTD-005



A = 1 P = 2140.67 T = 3.9968 S = 35.0835 SC = 6667 006.dat
CC115-CTD-006 12/7/90 17:30 689.25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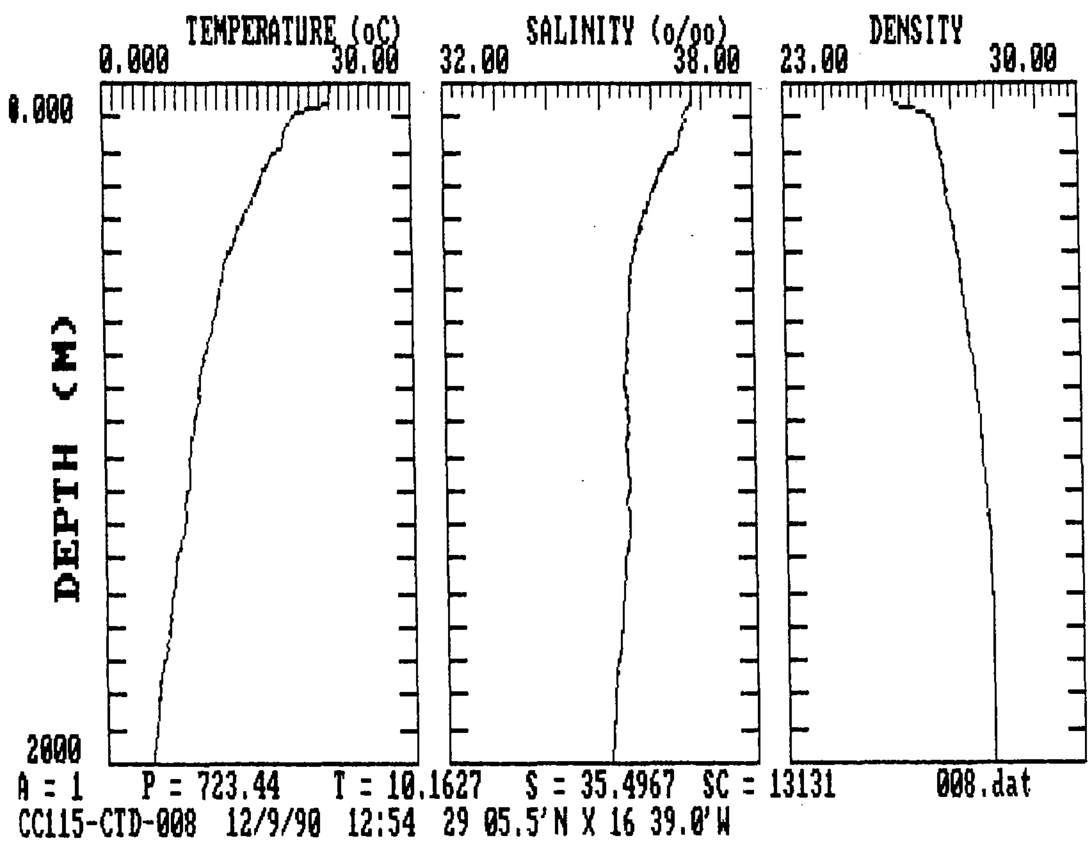
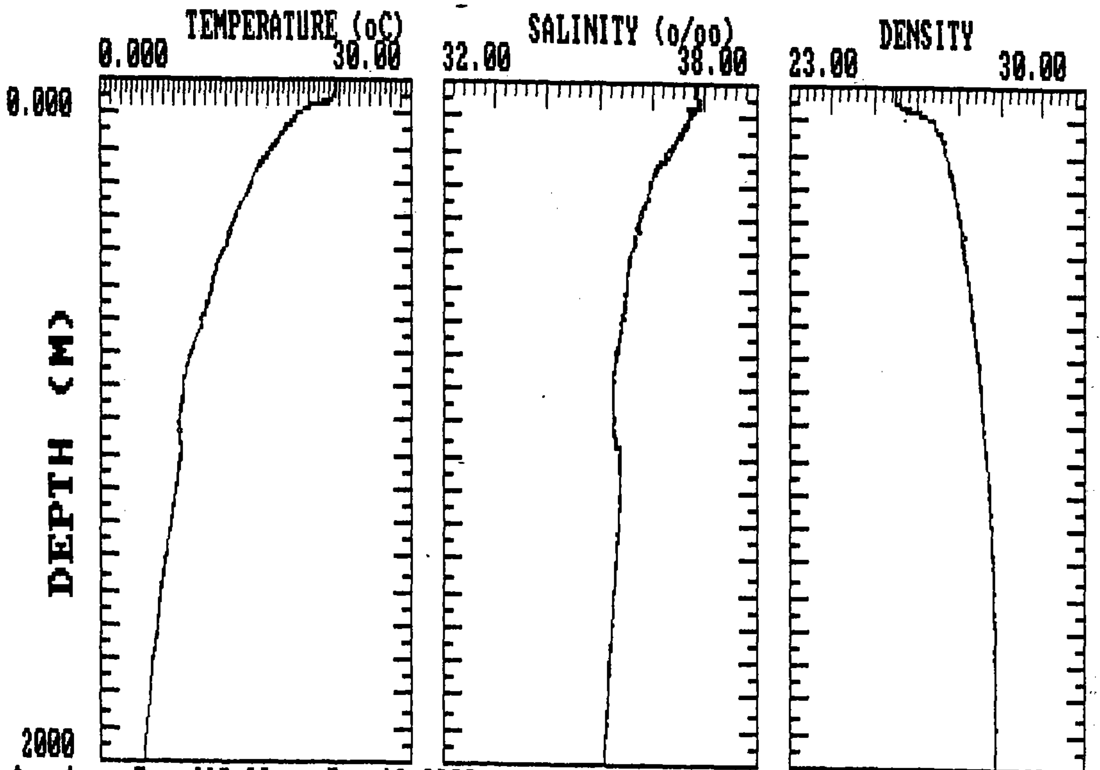
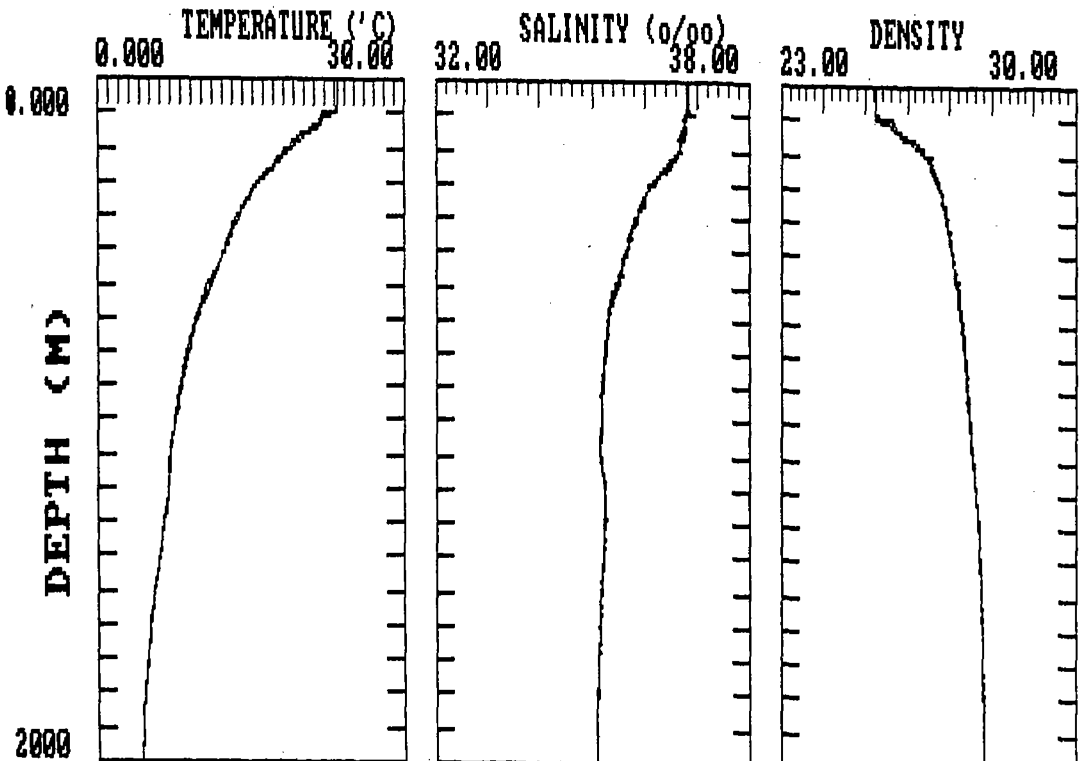
0.000
30.00
SALINITY (o/oo)
32.00
38.00
DENSITY
23.00
30.00
0.000
DEPTH (m)
2000
A = 1 P = 397.46 T = 12.9734 S = 35.7542 SC = 8889 007.dat
CC115-CTD-007 12/8/90 00:47 722.0

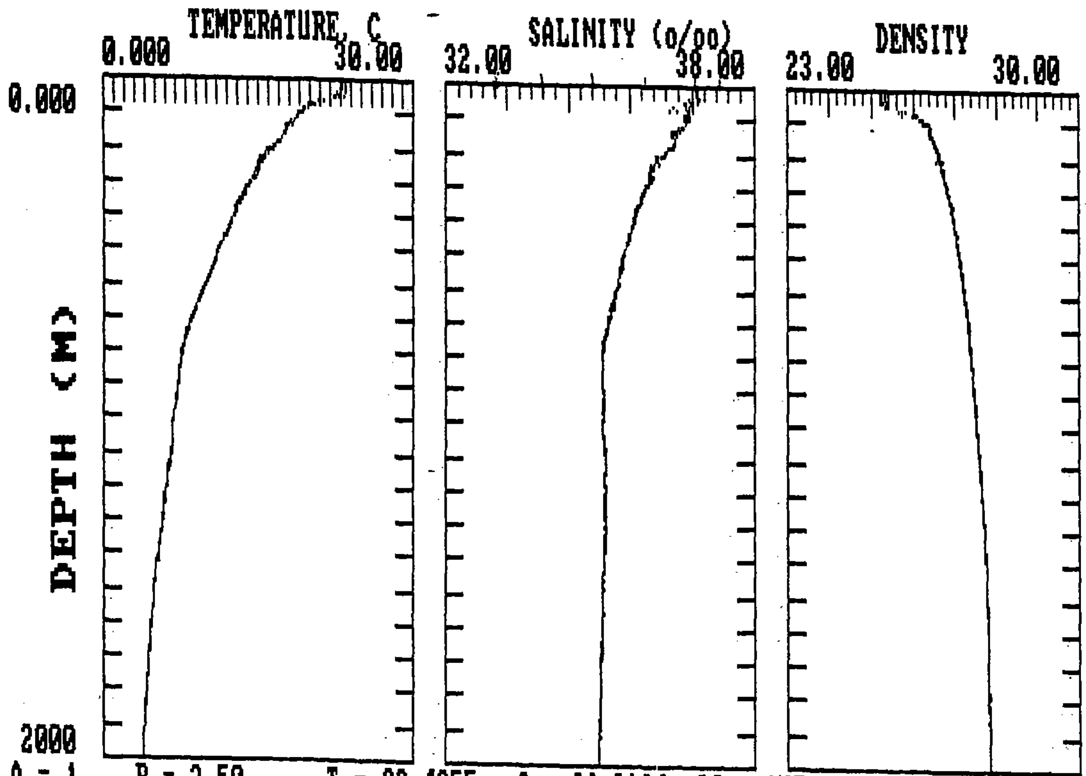

TEMPERATURE (oC)
0.000
30.00
SALINITY (o/oo)
32.00
38.00
DENSITY
23.00
30.00
0.000
DEPTH (M)
2000
A = 1 P = 723.44 T = 10.1627 S = 35.4967 SC = 13131 008.dat
CC115-CTD-008 12/9/90 12:54 29 05.5'N X 16 39.0'W



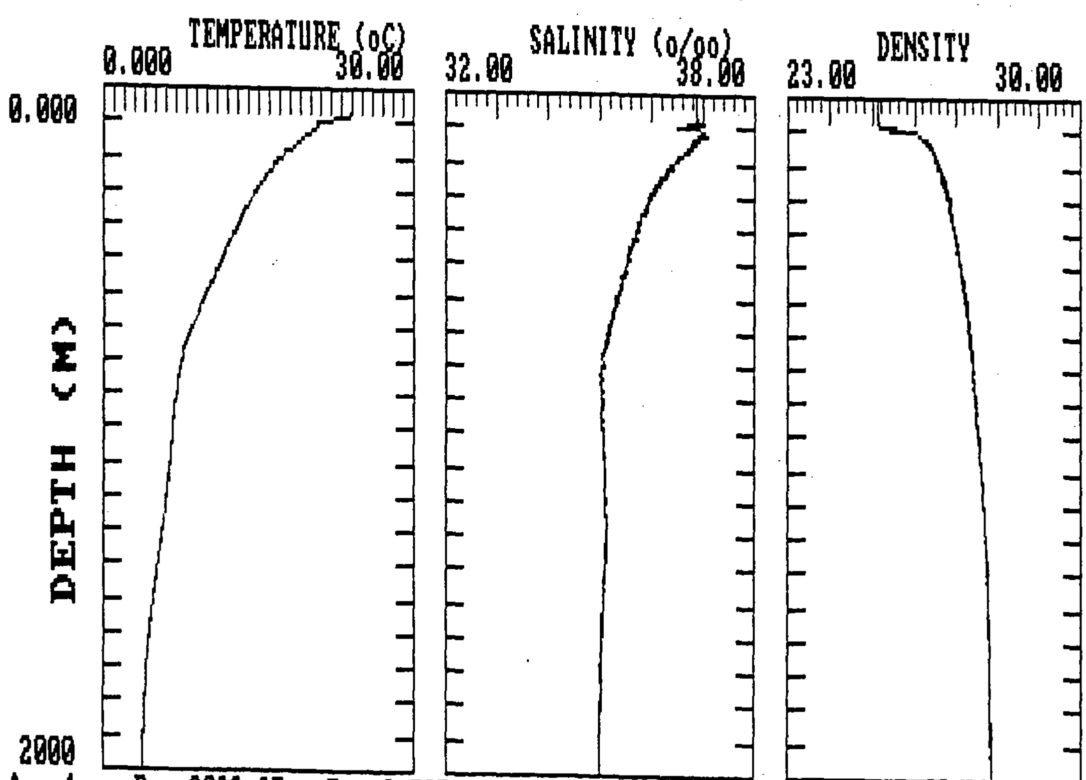
A = 1 P = 460.22 T = 12.3800 S = 35.6757 SC = 10606 009.dat
CC115-CTD-009 12-10-90 1056 LOG: 991.1



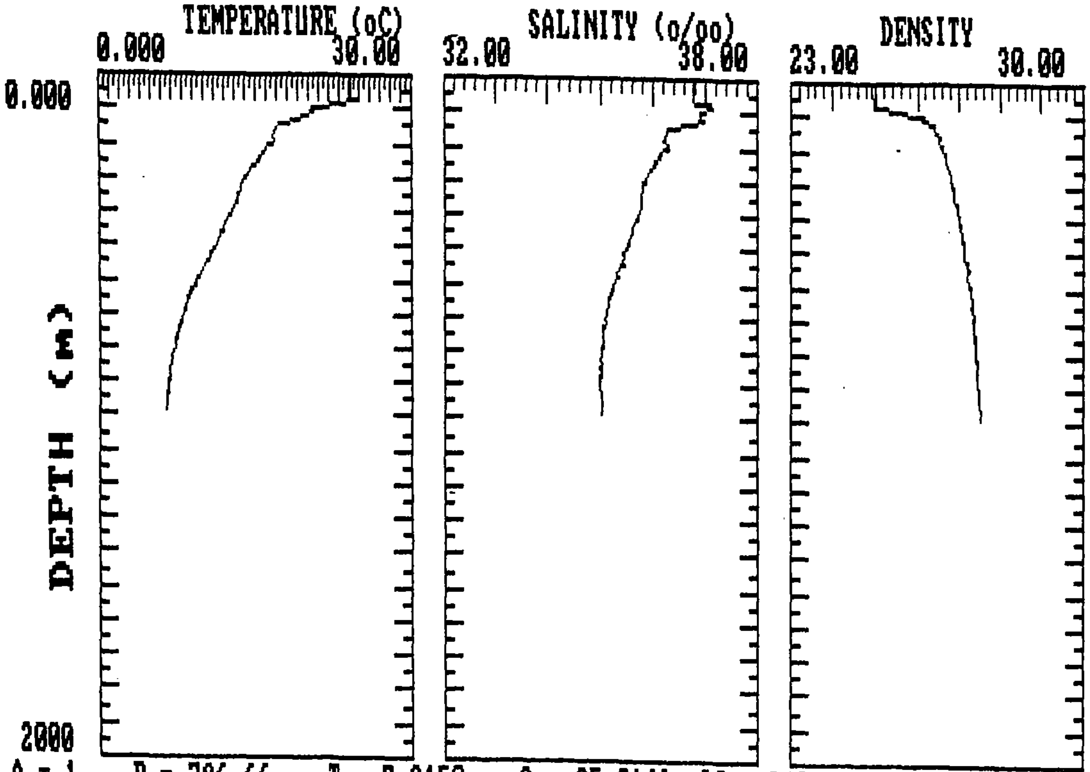
A = 1 P = 88.92 T = 23.2133 S = 36.8093 SC = 8889 010.dat
CC 115-CTD-010 12-11-90 10:42 LOG=1120.4



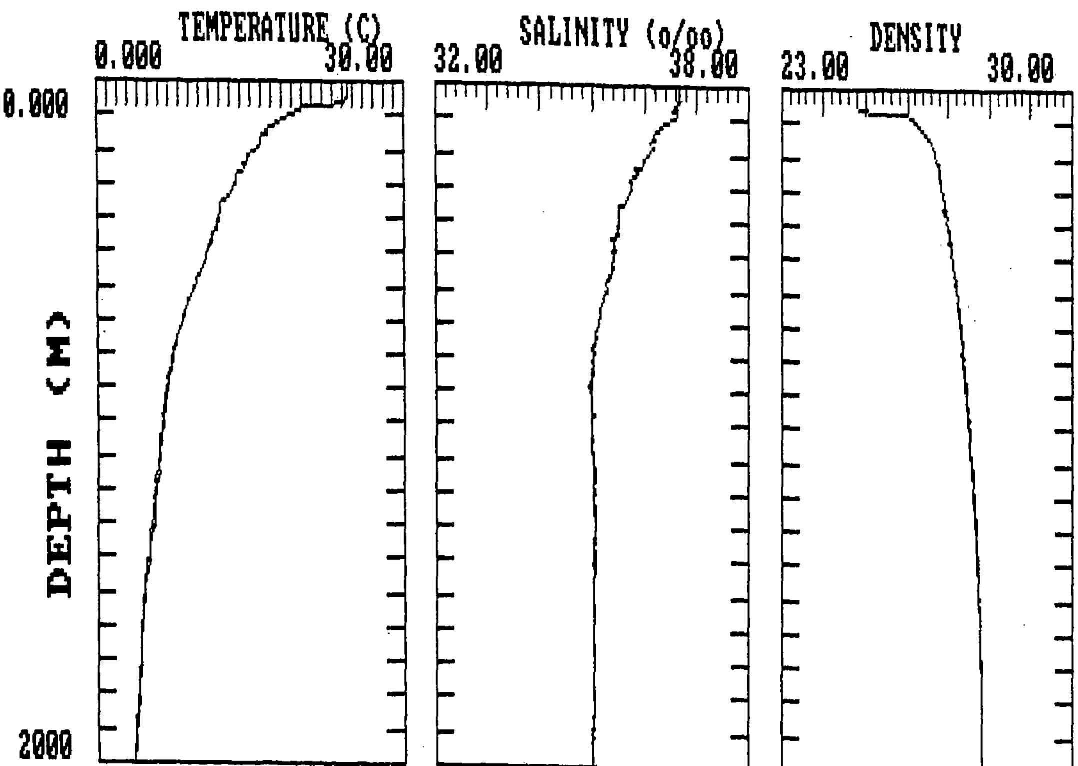
A = 1 P = 3.50 T = 23.4355 S = 36.9164 SC = 14545 012.dat
C115-CTD-012



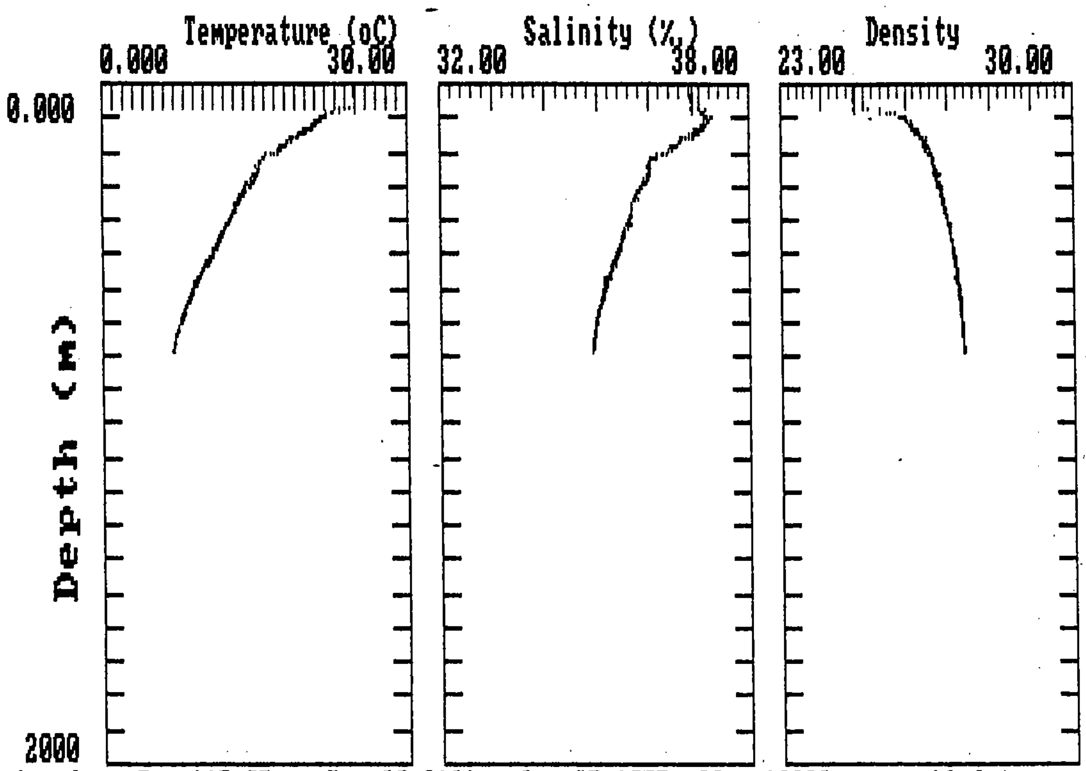
A = 1 P = 2023.87 T = 3.7251 S = 35.0058 SC = 5455 013.dat
CC115-CTD-013 12/13/90 21 58.2'N X 21 17.0W



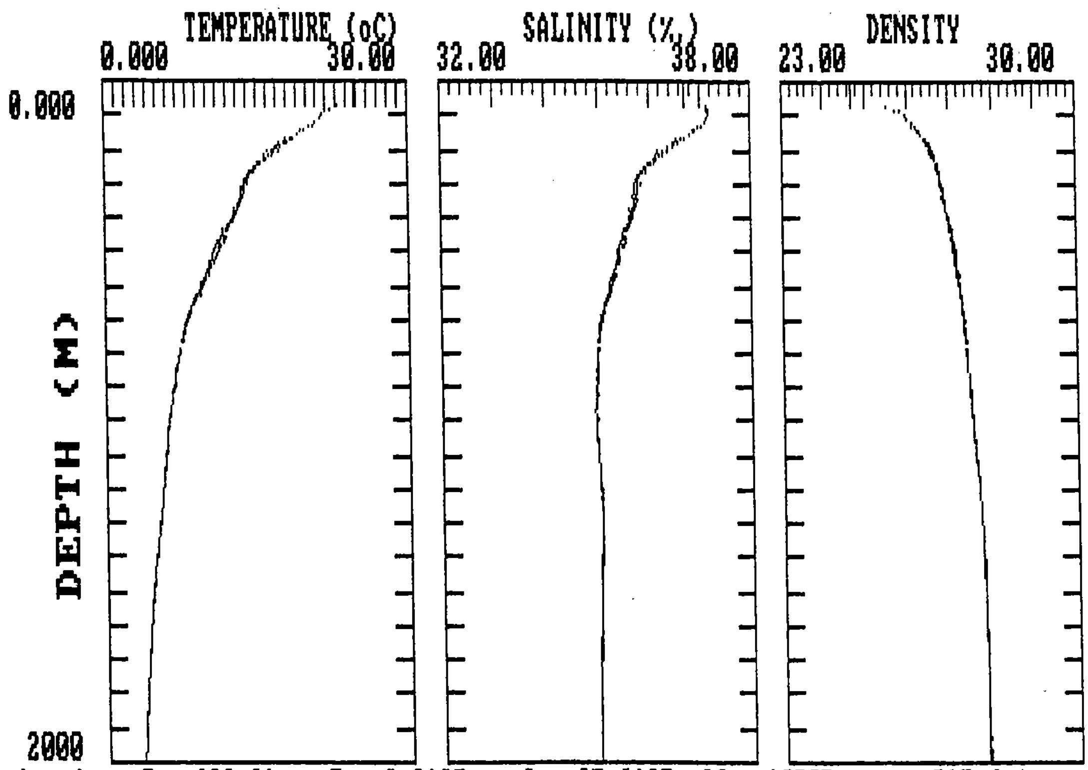
A = 1 P = 796.66 T = 7.3150 S = 35.0146 SC = 2627 014.dat
CC115-CTD-014 12/14/90 10:30 LOG=1485.6



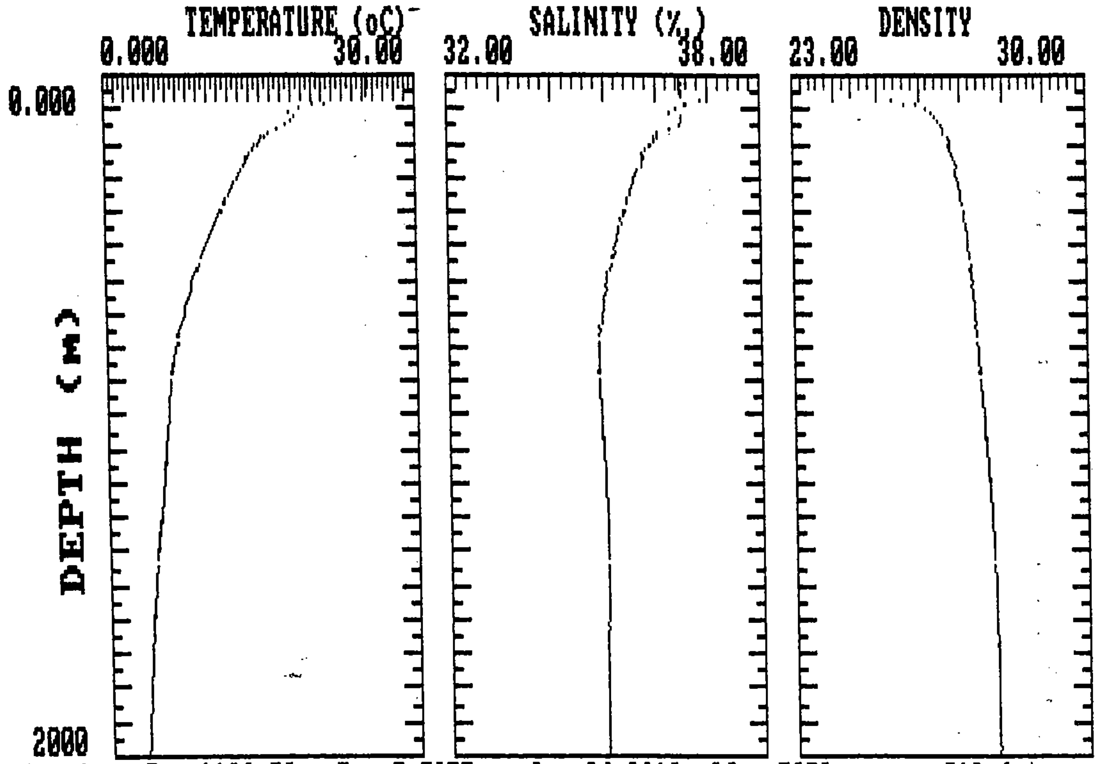
A = 1 P = 1258.61 T = 5.5727 S = 35.0204 SC = 8485 015.dat
CC115-CTD-015 12/15/90 20 0.1'N X 25 05.7'W



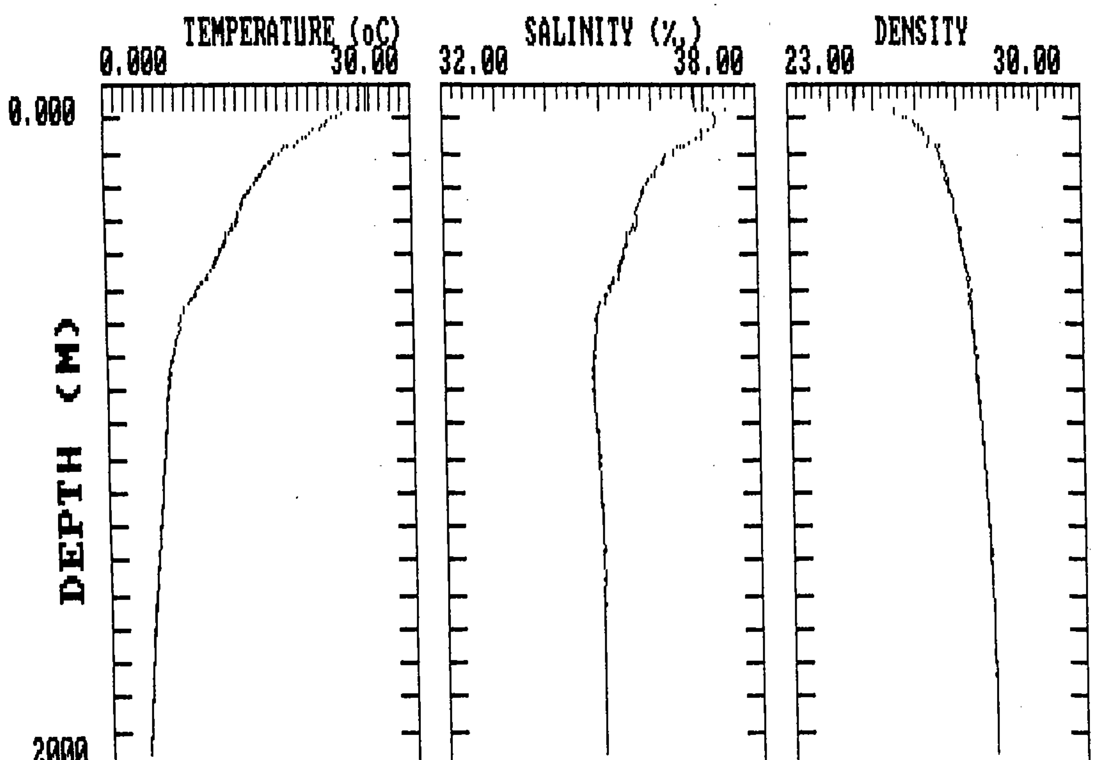
A = 1 P = 115.07 T = 20.9181 S = 37.1055 SC = 12929 16.dat
C115-CTD-016



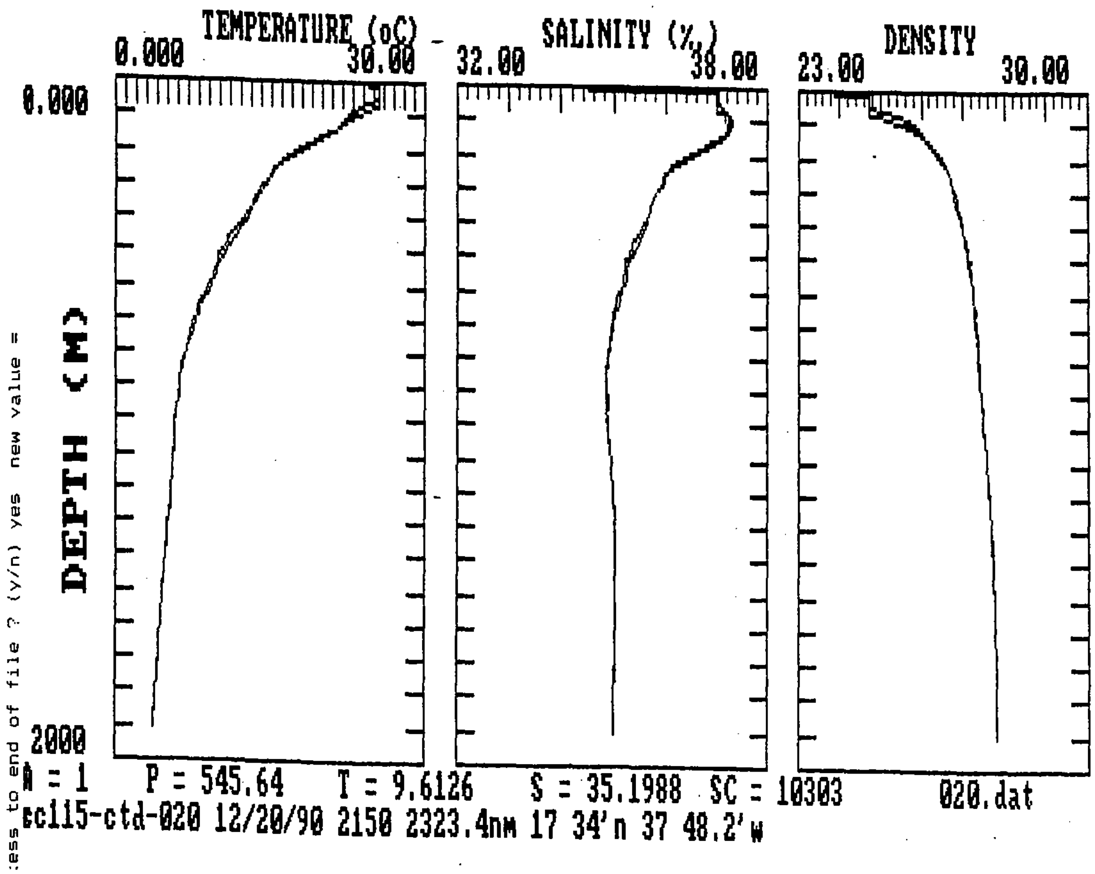
A = 1 P = 629.31 T = 9.3127 S = 35.2127 SC = 10505 017.dat
CC115-CTD-017 17 Dec 90 10:45 18 36.9'N x 29 42.0'W



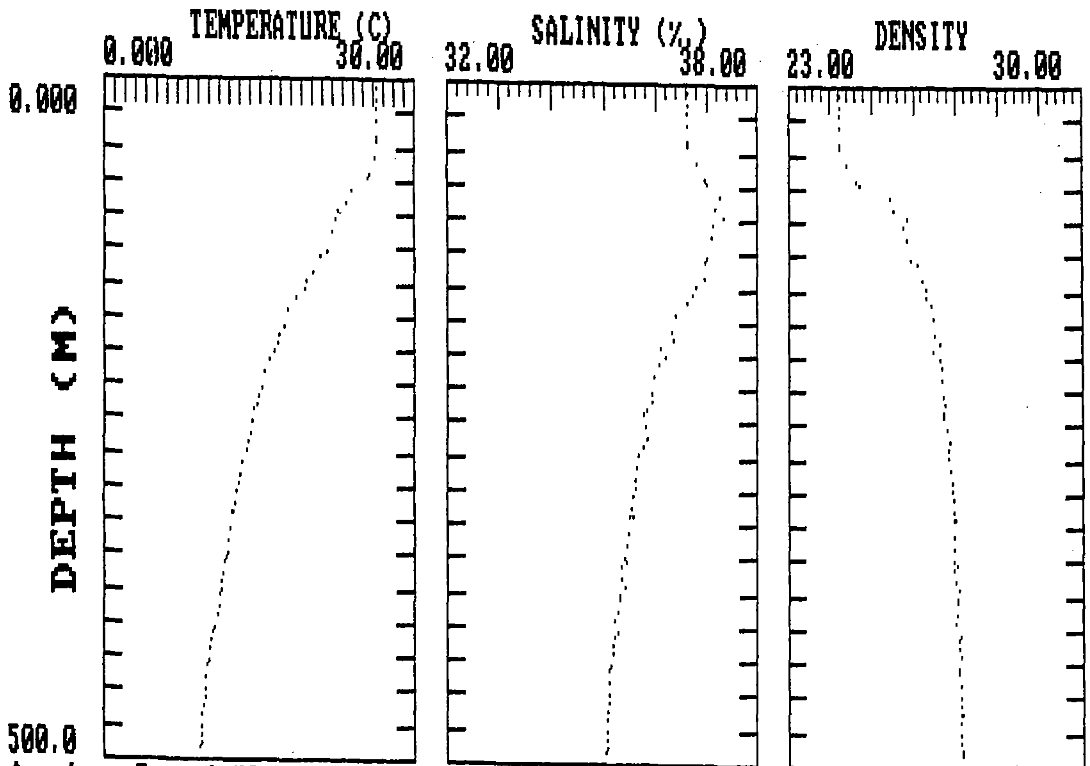
A = 1 P = 1136.58 T = 5.5955 S = 34.9612 SC = 7879 018.dat
CC115-CTD-018 12/18/90 10:46 LOG 1999.2 17 41.6'N X 32 09.0'W



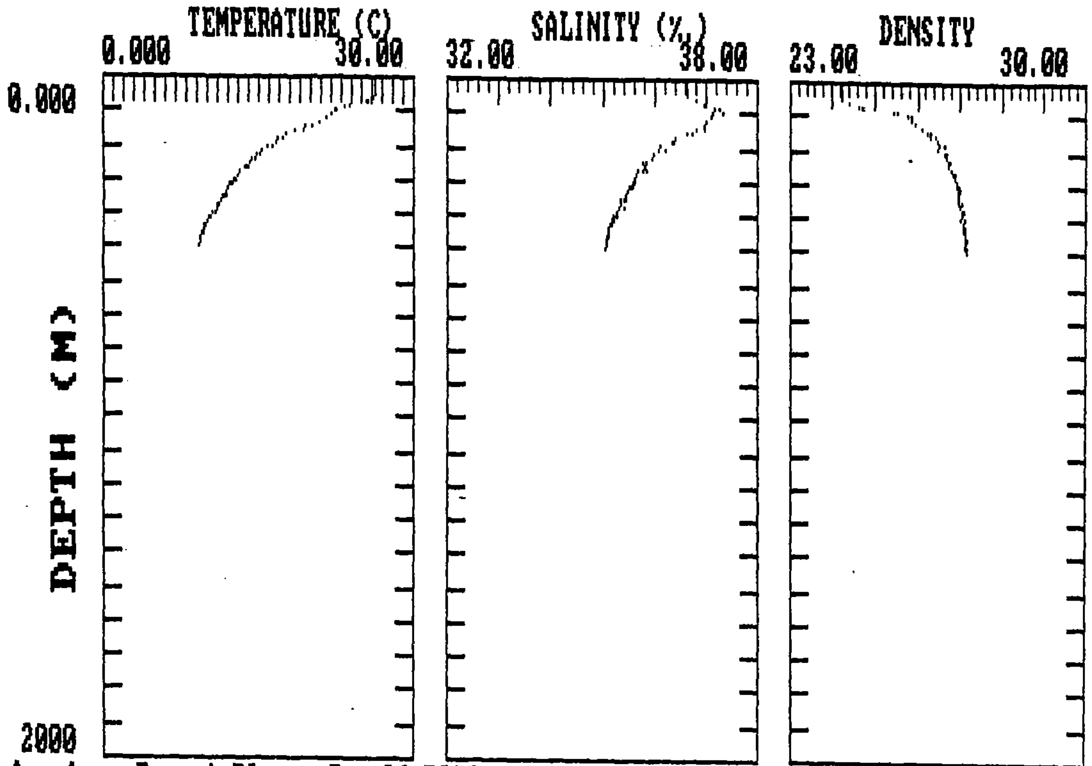
A = 1 P = 1809.46 T = 3.9087 S = 34.9837 SC = 6465 019.dat
CC-115-CTD-019 12/19/90 0028 LOG 2193.8 17 9.8'N X 35 24.8'W



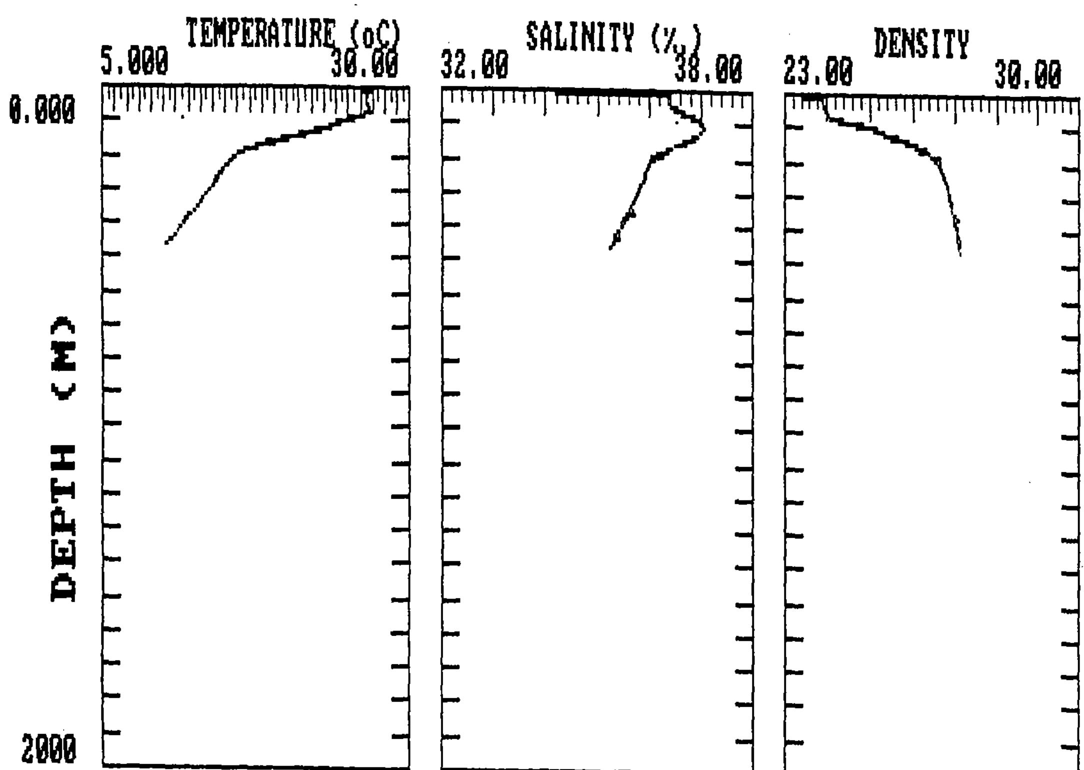
A = 1 P = 545.64 T = 9.6126 S = 35.1988 SC = 10303 020.dat
sc115-ctd-020 12/20/90 2150 2323.4nm 17 34'n 37 48.2'w



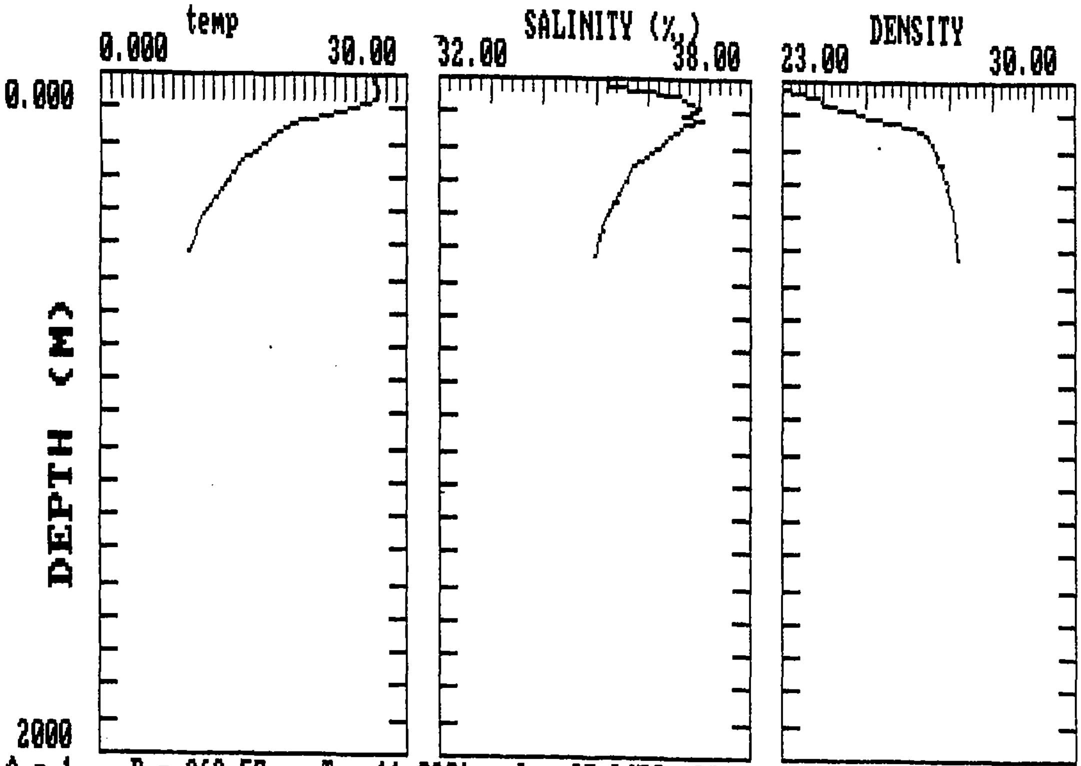
A = 1 P = -1.73 T = 24.7300 S = 0.3033 SC = 4222 021.dat
15-CTD-021 12/22/90 1052 2533.8 nm 16 24.6'N X 41 33.5'W



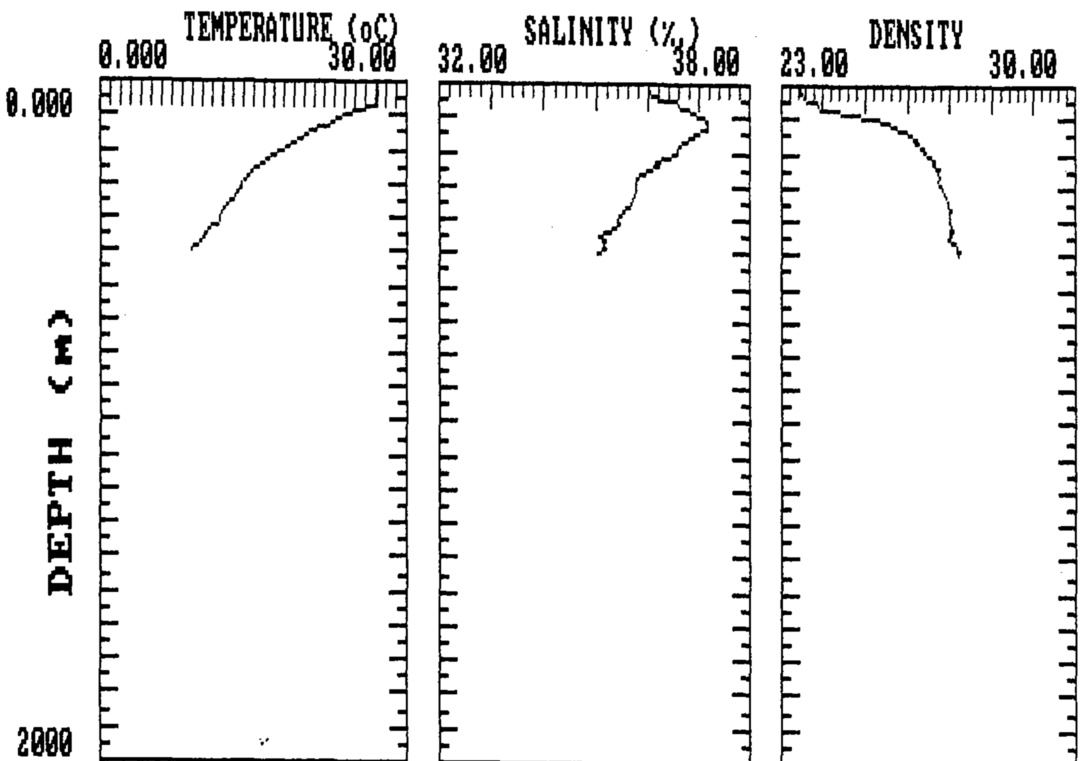
A = 1 P = -1.73 T = 24.7300 S = 0.3033 SC = 4222 021.dat
CC115-CTD-021 1052 2533.8 16 24.6'N 41 33.5'W



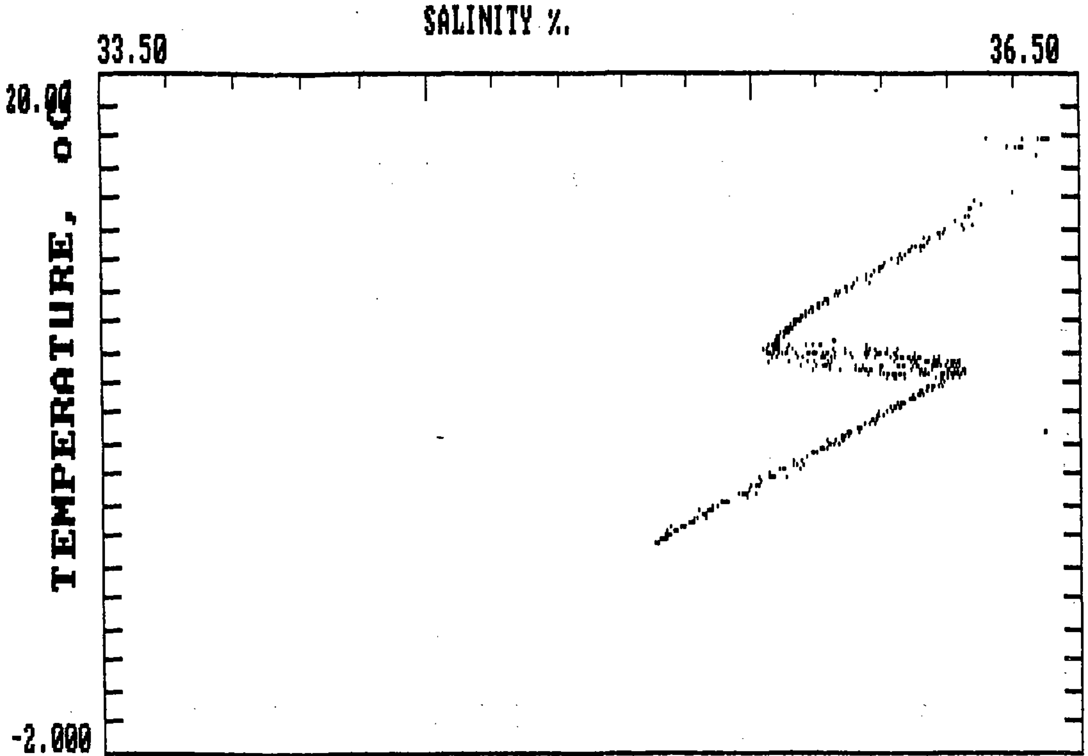
A = 1 P = 198.74 T = 16.0305 S = 36.0366 SC = 2143 ~~jeg.dat~~
cc115-ctd-022, 12/24/90, 1100, 2819nm, 16 01.0'n x 47 14.5'w 022.DAT



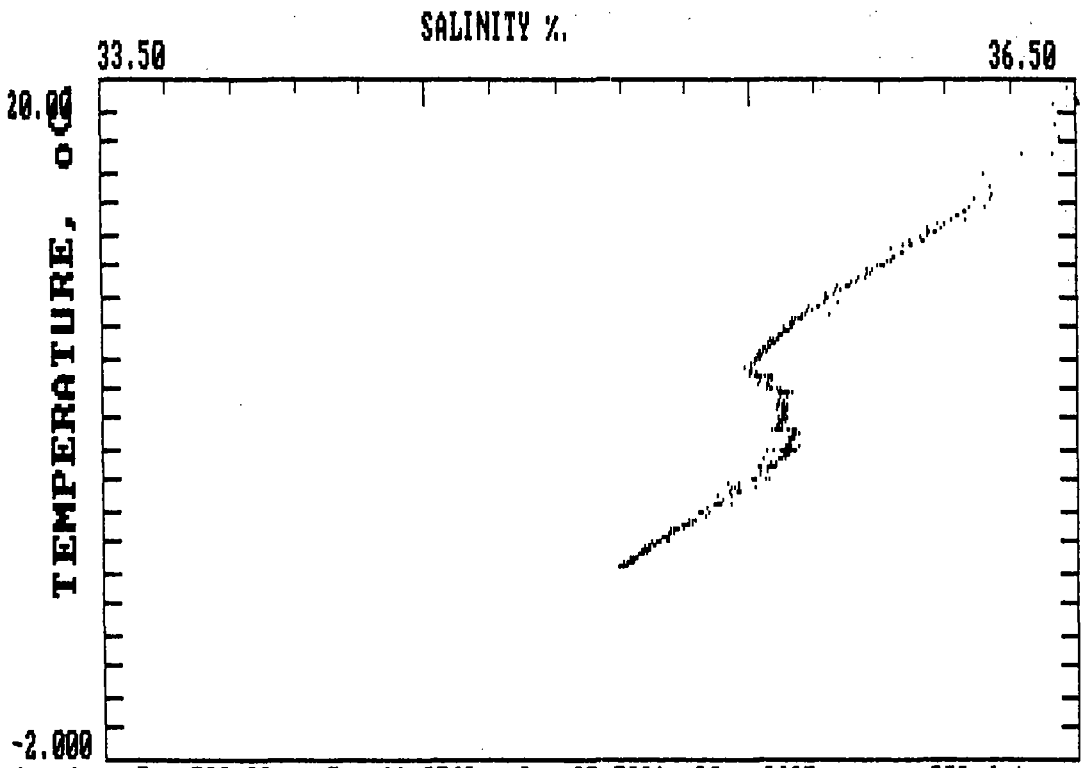
A = 1 P = 369.57 T = 11.0901 S = 35.3470 SC = 2627 023.dat
CTD-023 12/25/90 LOG:2976.5 14 59'N x 49 52.1'W MID-ATLANTIC RIDGE ARE



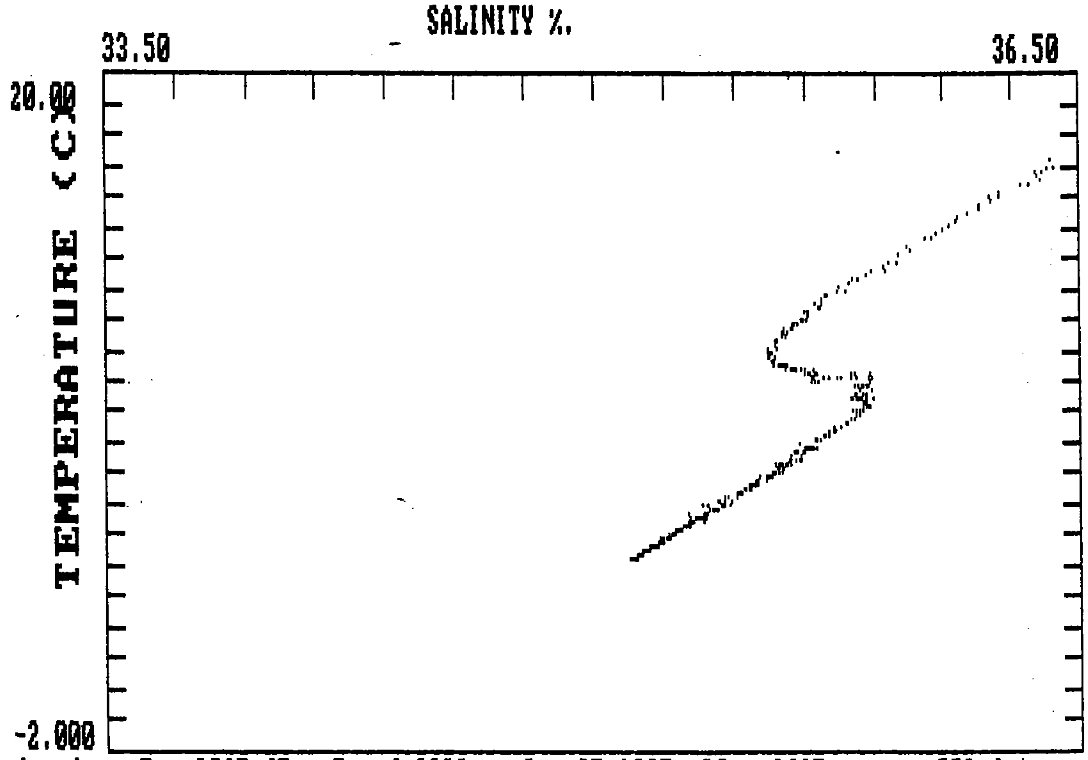
A = 1 P = 36.62 T = 27.0352 S = 36.0326 SC = 2627 024.dat
CC115-CTD-024 1230 15 46.0'W 51 34.7'W



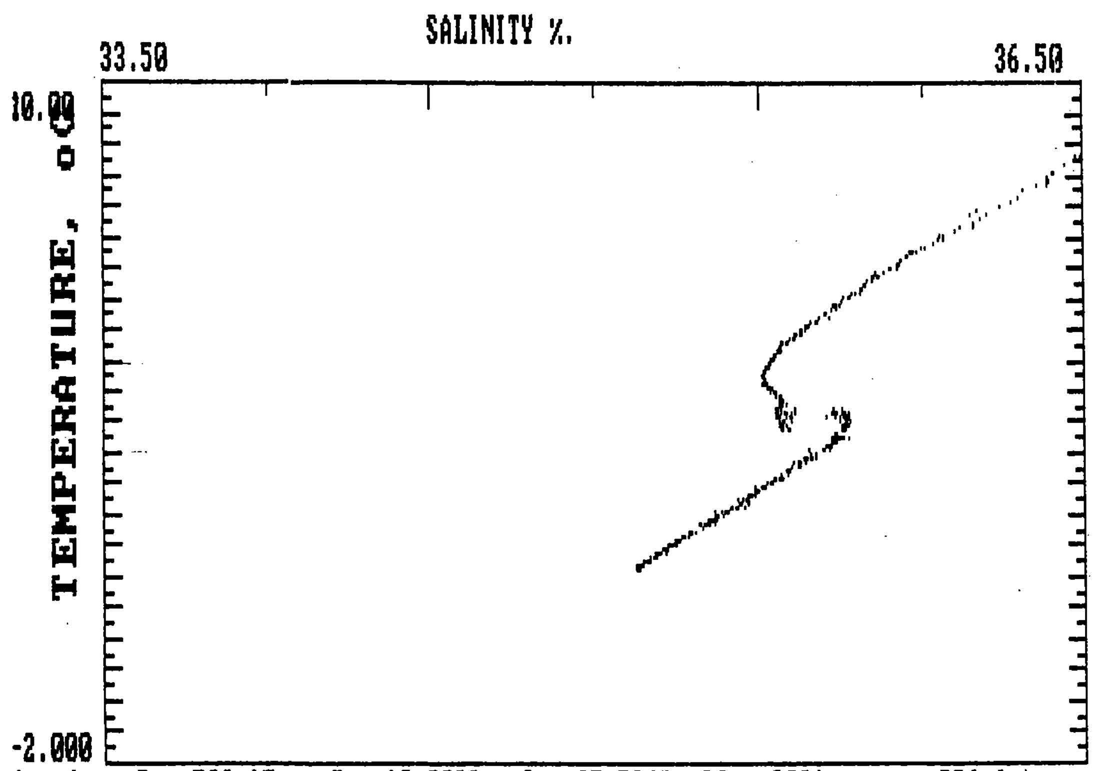
A = 1 P = 141.21 T = 14.9644 S = 36.0893 SC = 9697 001.dat
C115-CTD-001 TS DIAGRAM



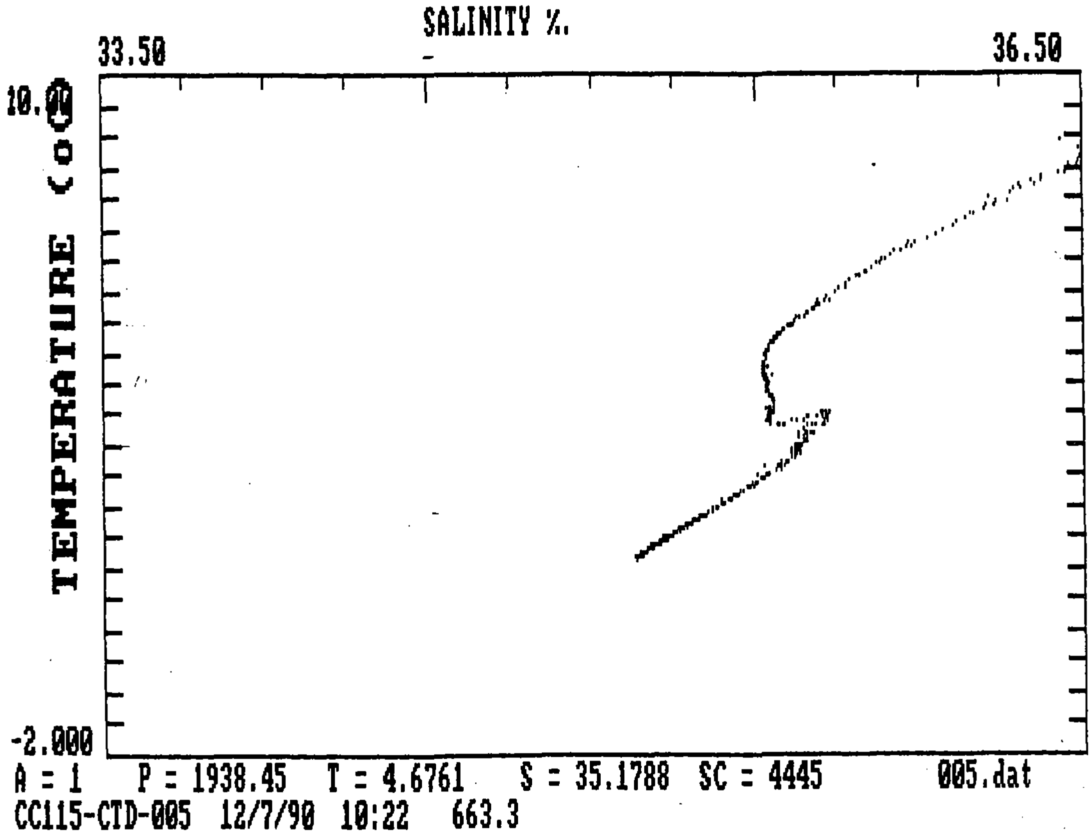
A = 1 P = 583.99 T = 11.2743 S = 35.5381 SC = 9697 002.dat
C115-CTD-002 TS DIAGRAM

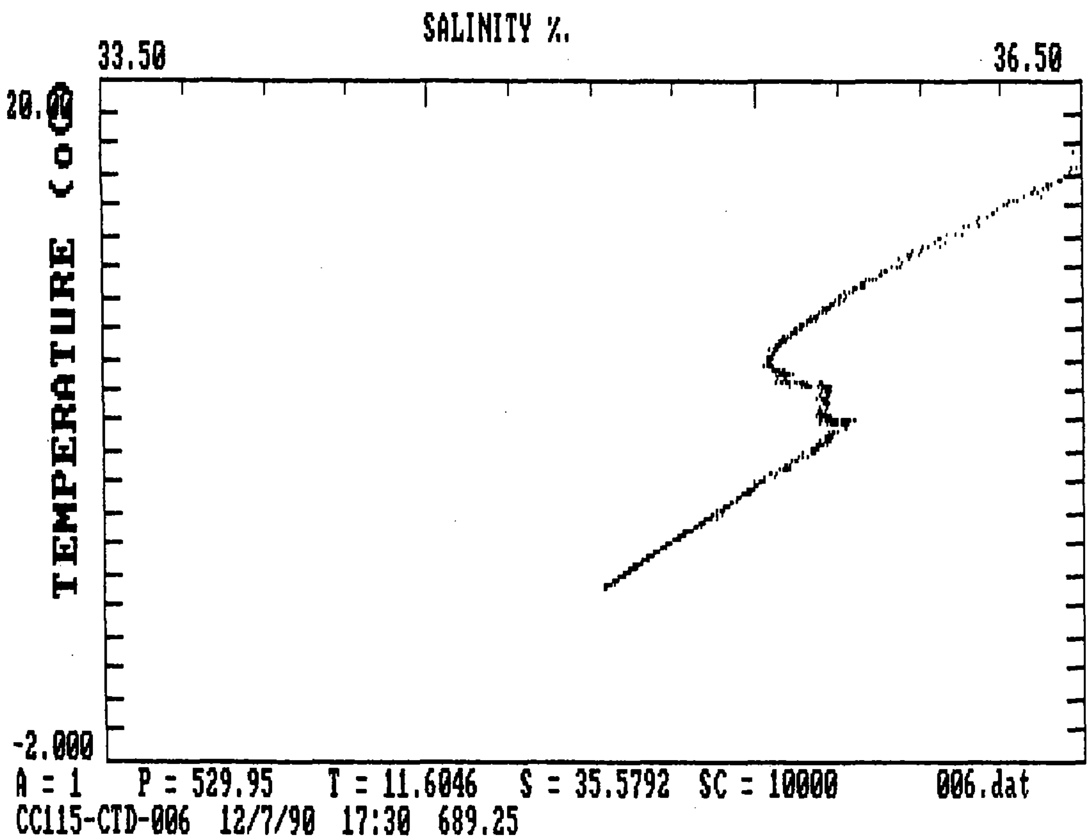


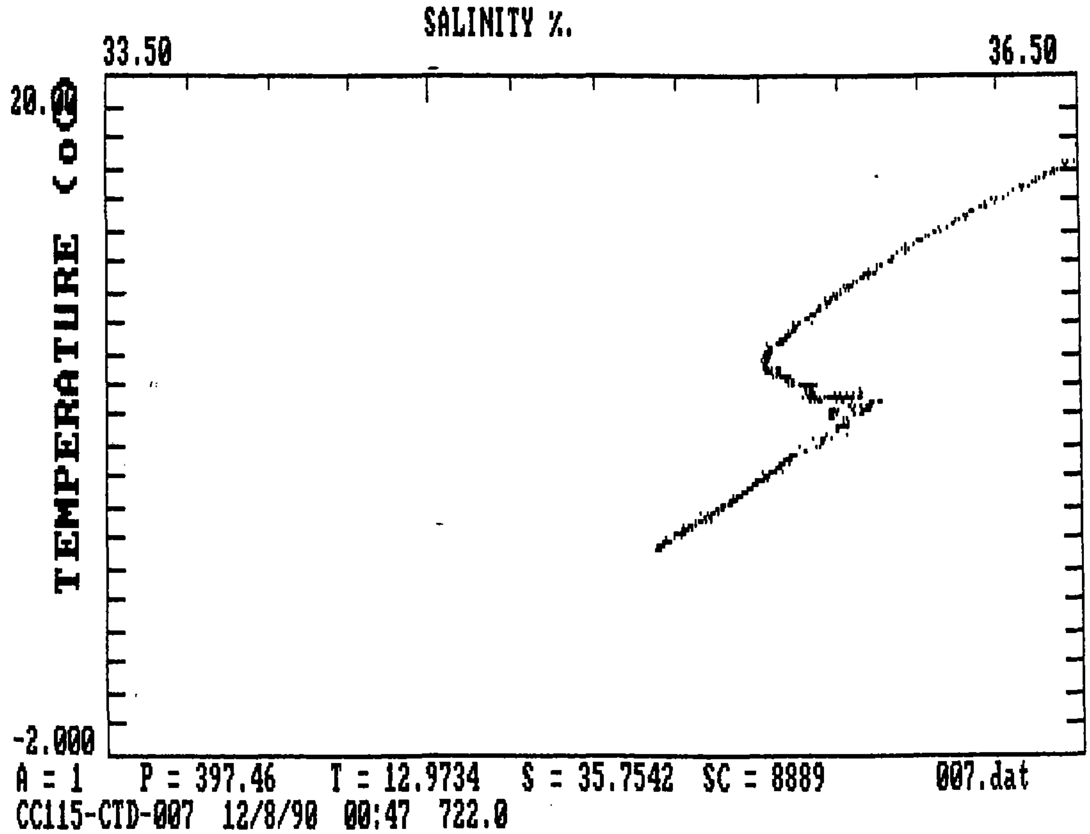
A = 1 P = 2067.45 T = 4.3382 S = 35.1327 SC = 6465 003.dat
C115-CTD-003 TS DIAGRAM

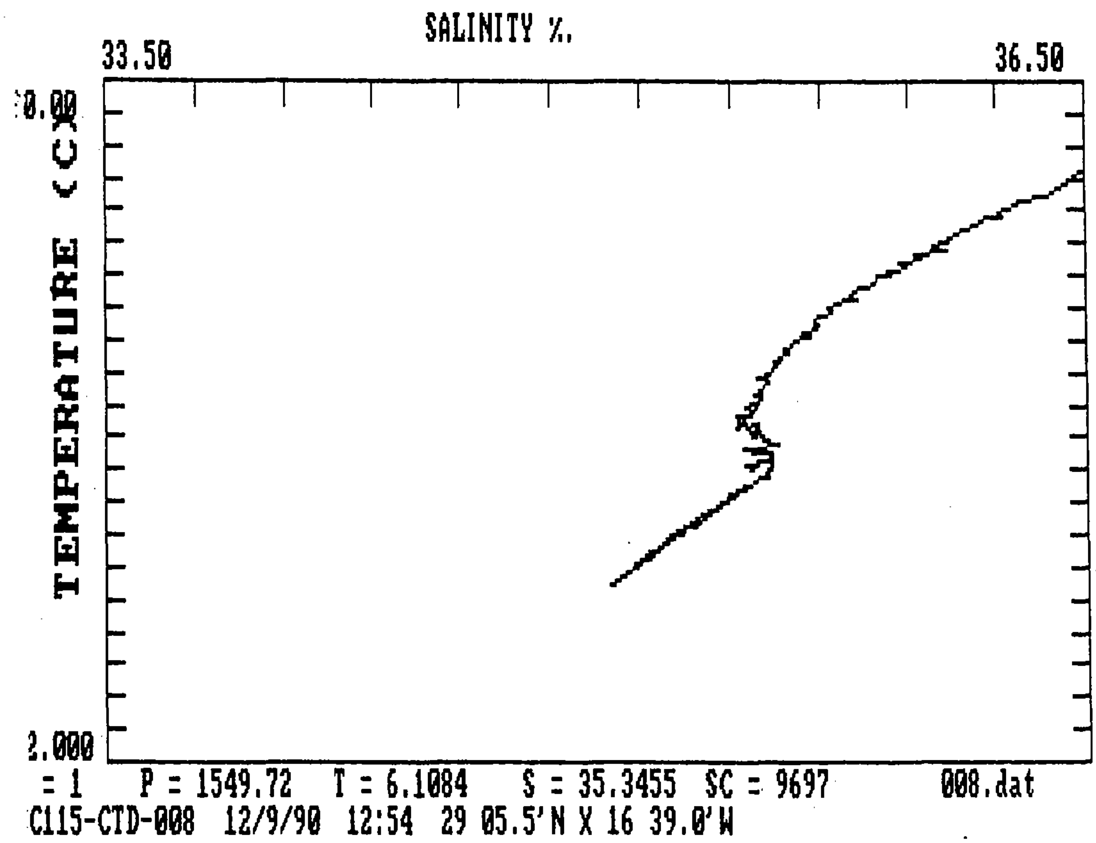


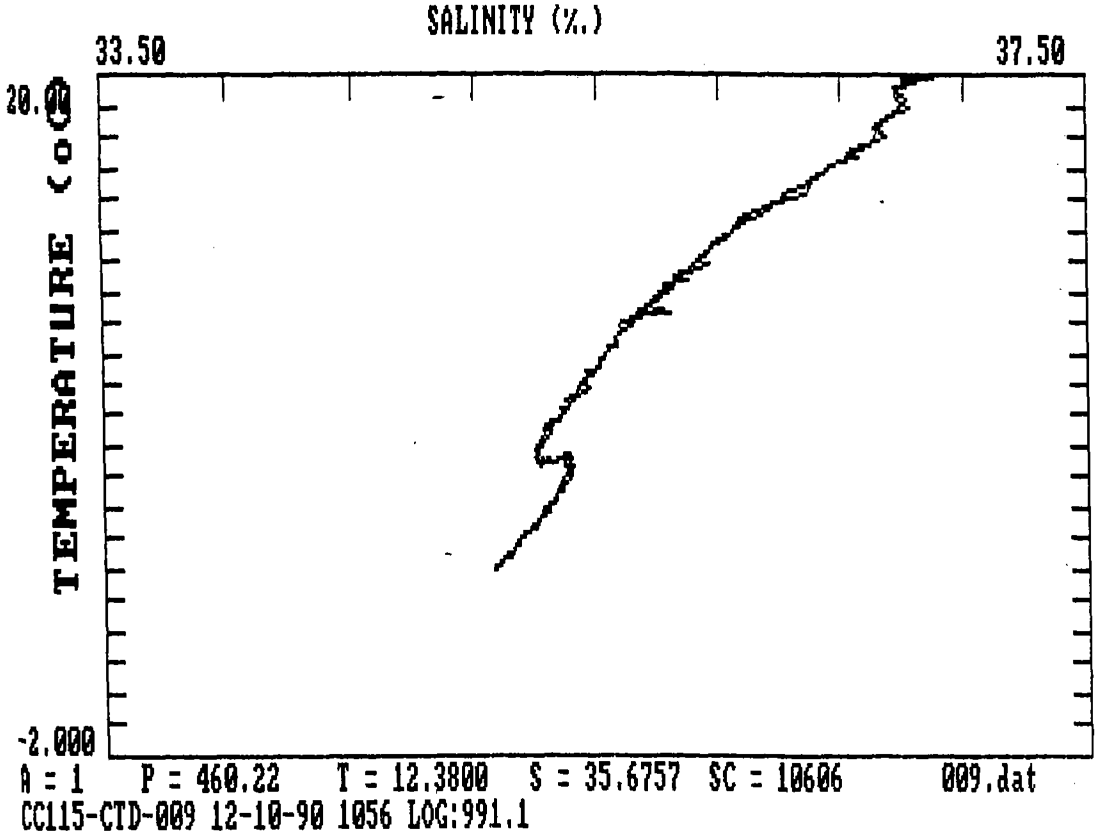
A = 1 P = 793.17 T = 10.0099 S = 35.5348 SC = 8081 004.dat
C115-CTD-004 TS DIAGRAM

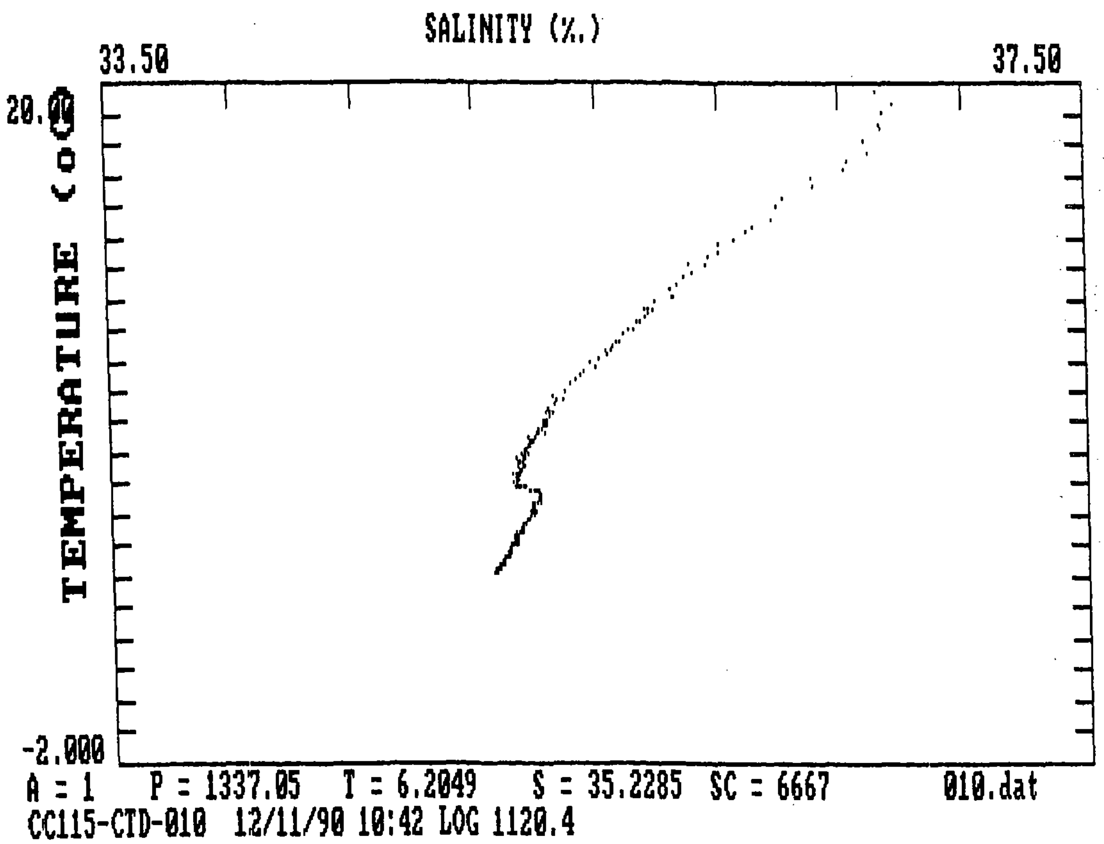

SALINITY %.
33.50
36.50
10.00
TEMPERATURE (oC)
-2.000
A = 1   P = 1938.45   T = 4.6761   S = 35.1788   SC = 4445   005.dat
CC115-CTD-005 12/7/90 10:22   663.3

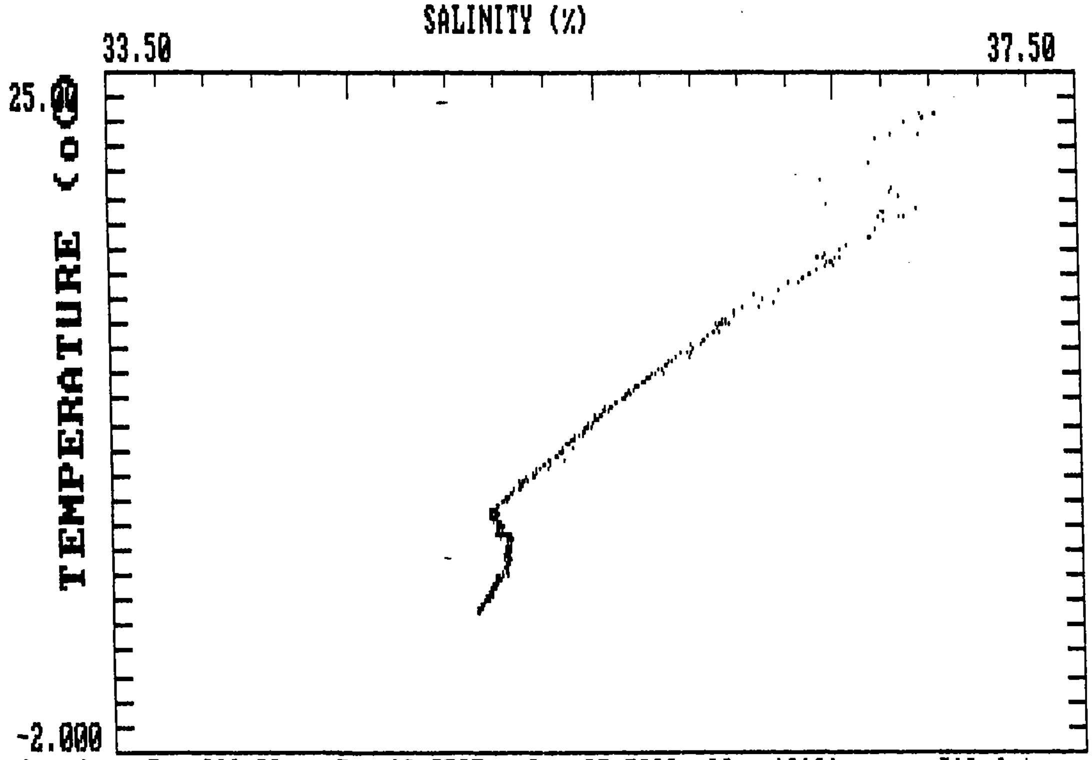

SALINITY %.
33.50
36.50
20.00
TEMPERATURE (oC)
-2.000
A = 1   P = 529.95   T = 11.6046   S = 35.5792   SC = 10000   006.dat
CC115-CTD-006 12/7/90 17:30 689.25


SALINITY %.
33.50
36.50
20.00
TEMPERATURE (C)
-2.000
A = 1 P = 397.46 T = 12.9734 S = 35.7542 SC = 8889 007.dat
CC115-CTD-007 12/8/90 00:47 722.0

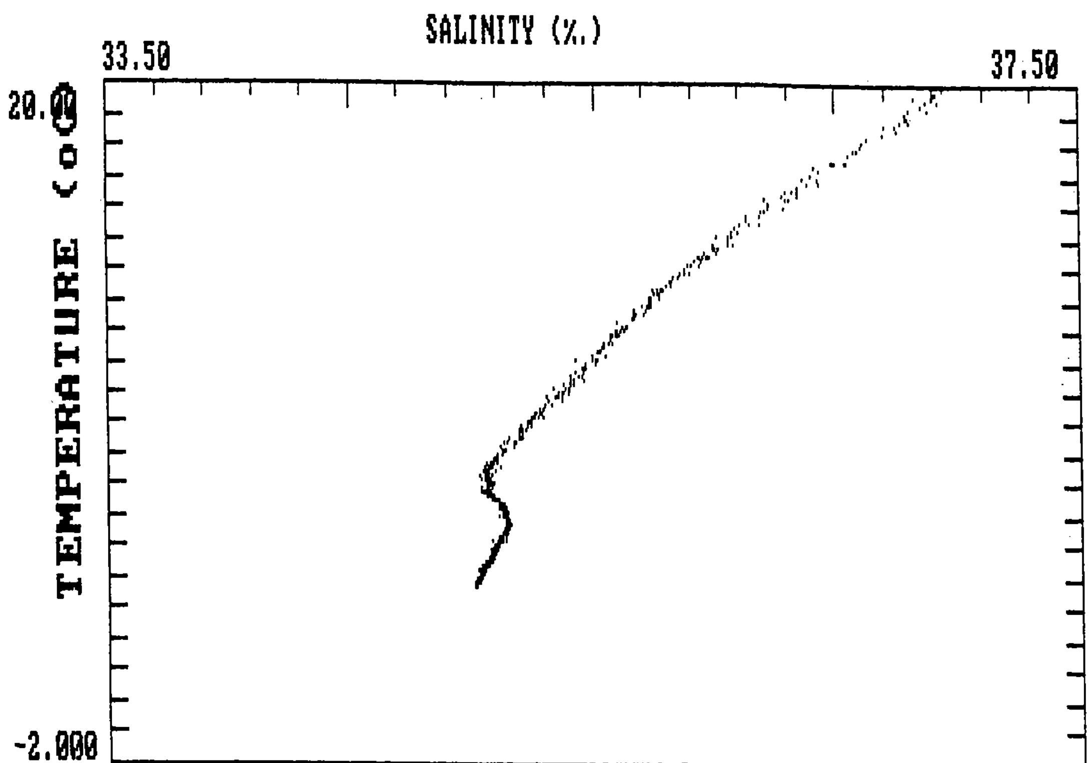

SALINITY %.
33.50
36.50
0.00
TEMPERATURE (C)
2.000
= 1 P = 1549.72 T = 6.1084 S = 35.3455 SC = 9697 008.dat
C115-CTD-008 12/9/90 12:54 29 05.5'N X 16 39.0'W


SALINITY (‰)
33.50
37.50
20.00
-2.000
TEMPERATURE (C°)
A = 1   P = 460.22   T = 12.3800   S = 35.6757   SC = 10606   009.dat
CC115-CTD-009 12-10-90 1056 LOG:991.1

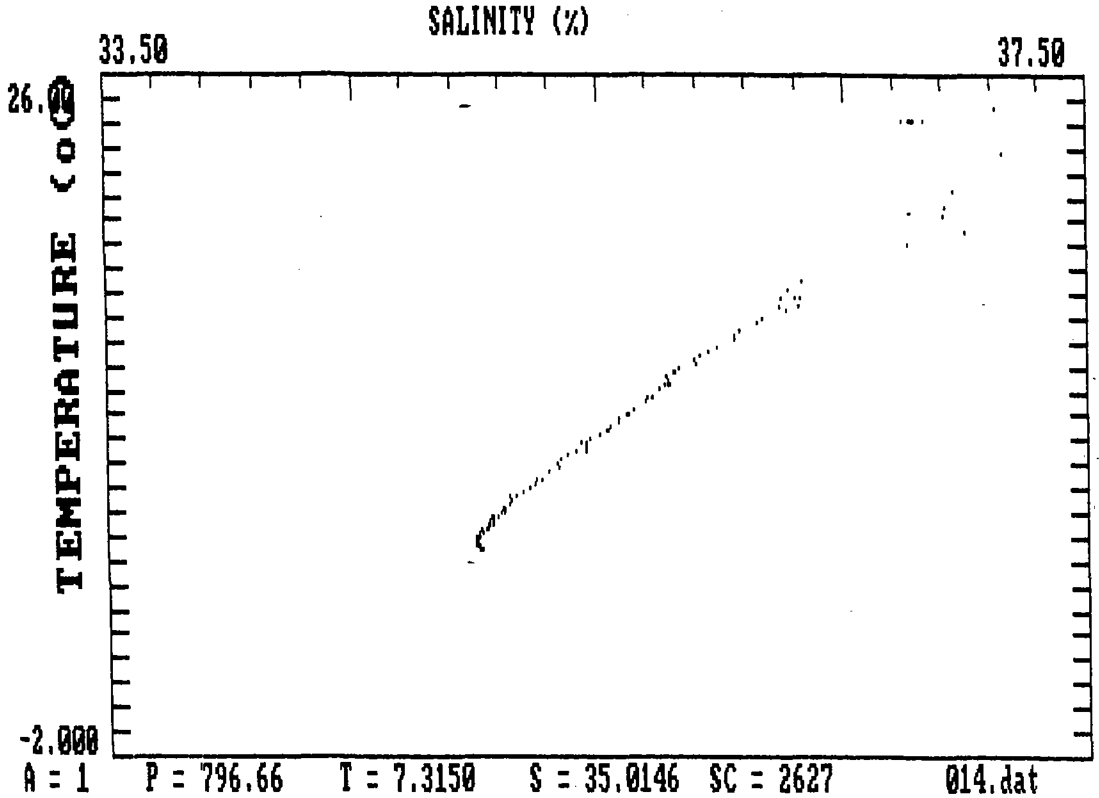

SALINITY (‰)
33.50
37.50
20.00
-2.000
TEMPERATURE (C°)
A = 1   P = 1337.05   T = 6.2049   S = 35.2285   SC = 6667   010.dat
CC115-CTD-010 12/11/90 10:42 LOG 1120.4



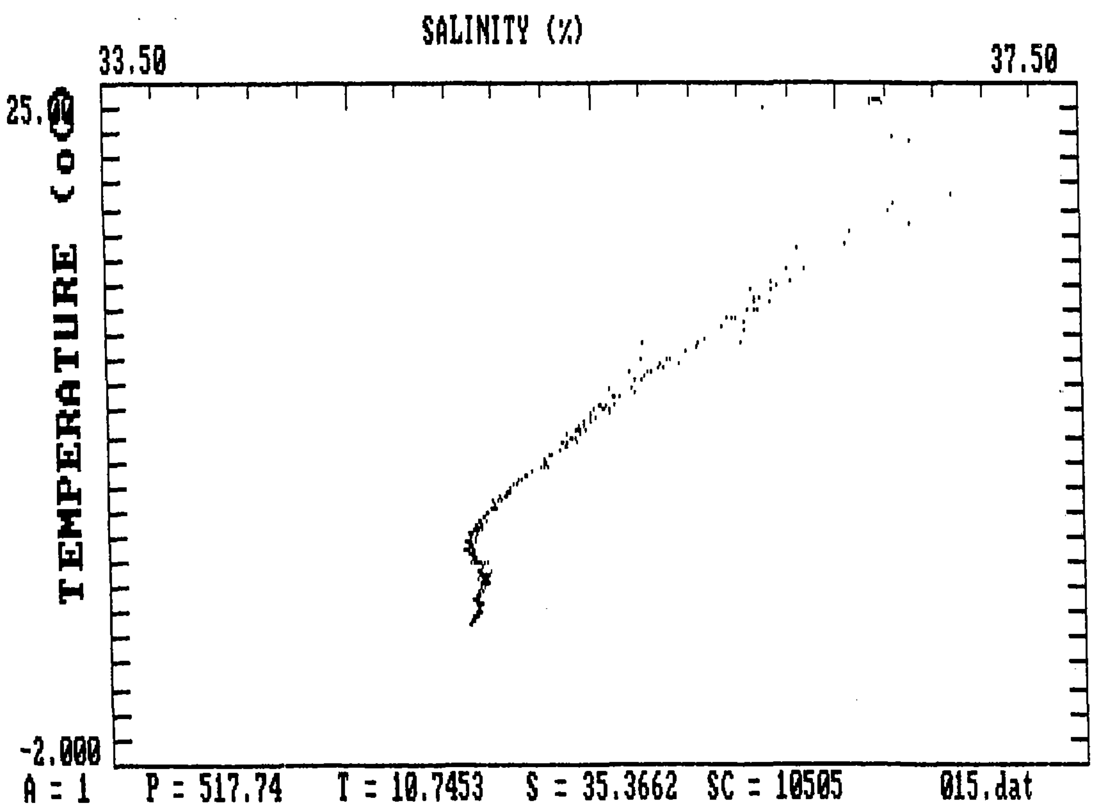
A = 1 P = 366.09 T = 13.0787 S = 35.7392 SC = 13131 012.dat
CC115-CTD-012 12/12/90 19:28 LOG 1292.9



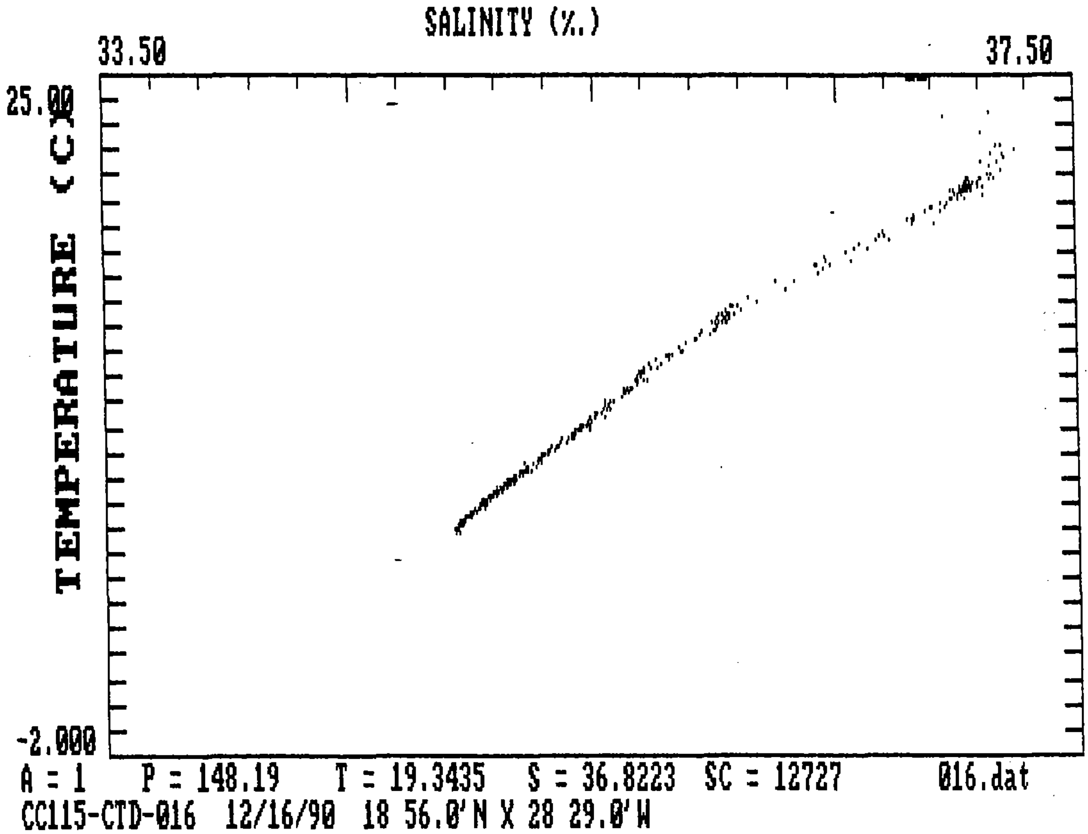
A = 1 P = 2023.87 T = 3.7251 S = 35.0058 SC = 5455 013.dat
CC115-CTD-013 TS DIAGRAM

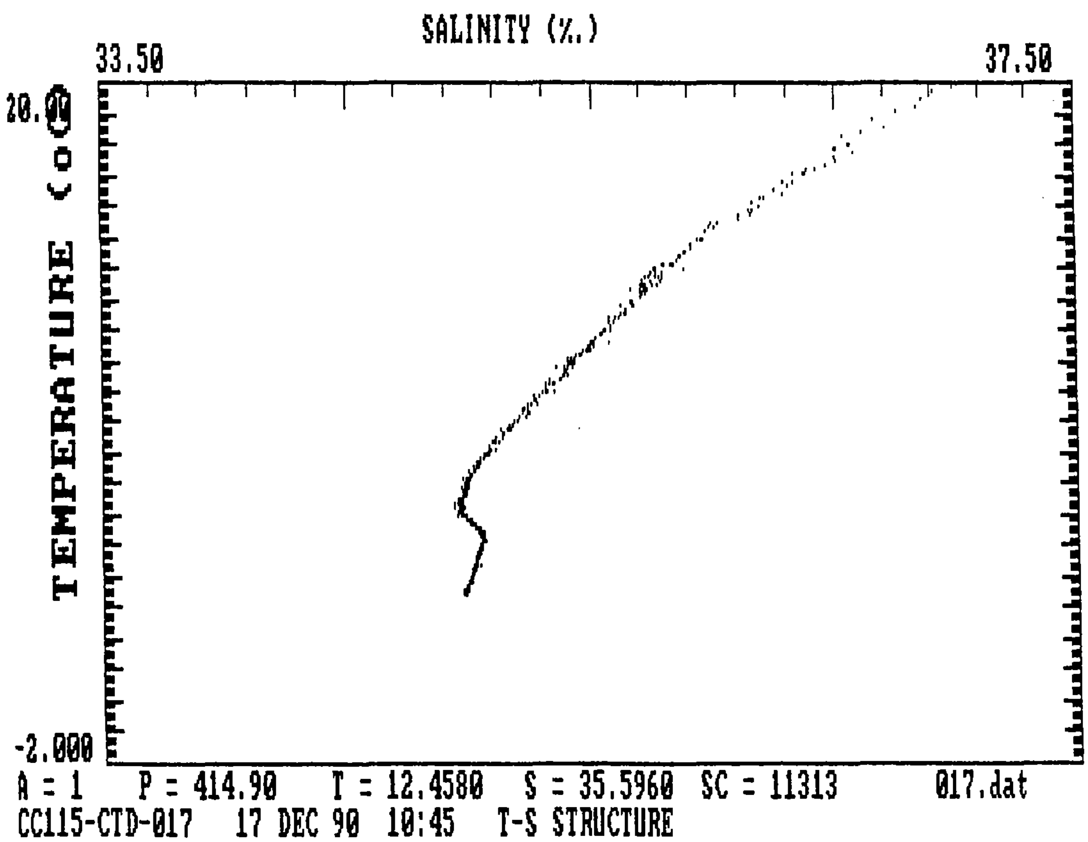


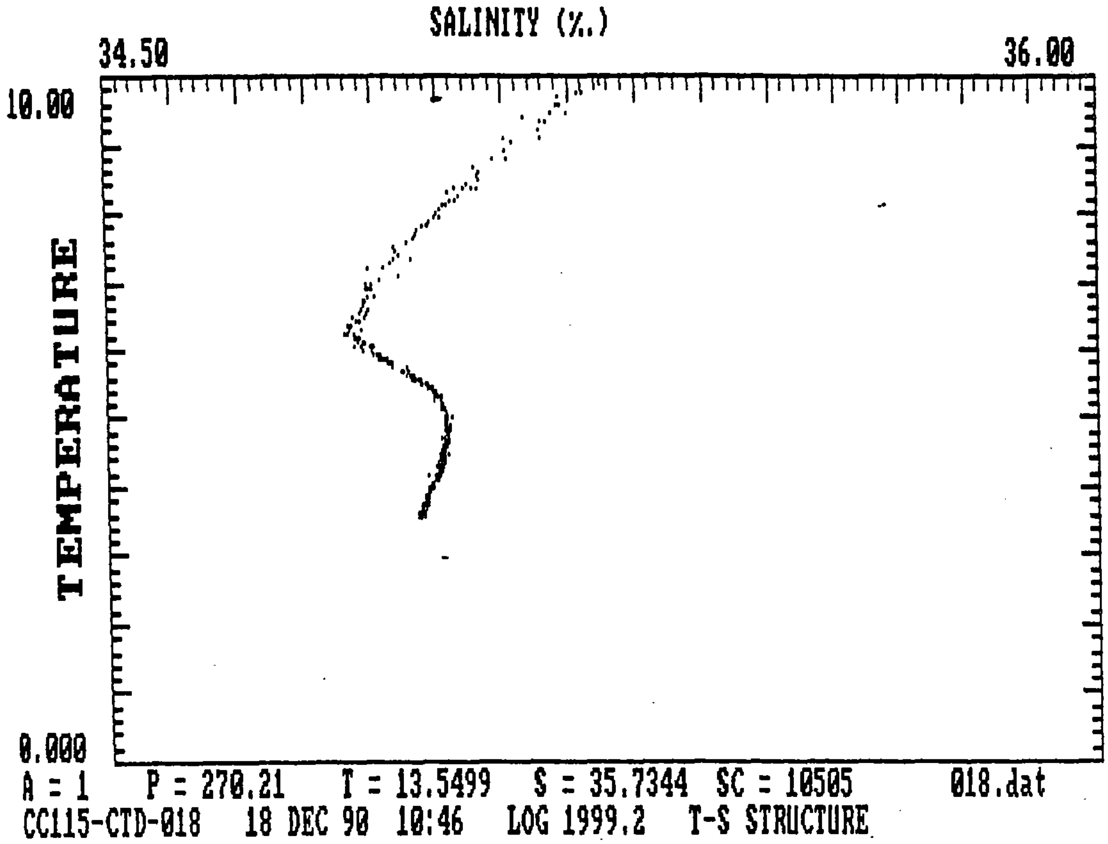
CC115-CTD-014 12/14/90 10:30 LOG 1485.6

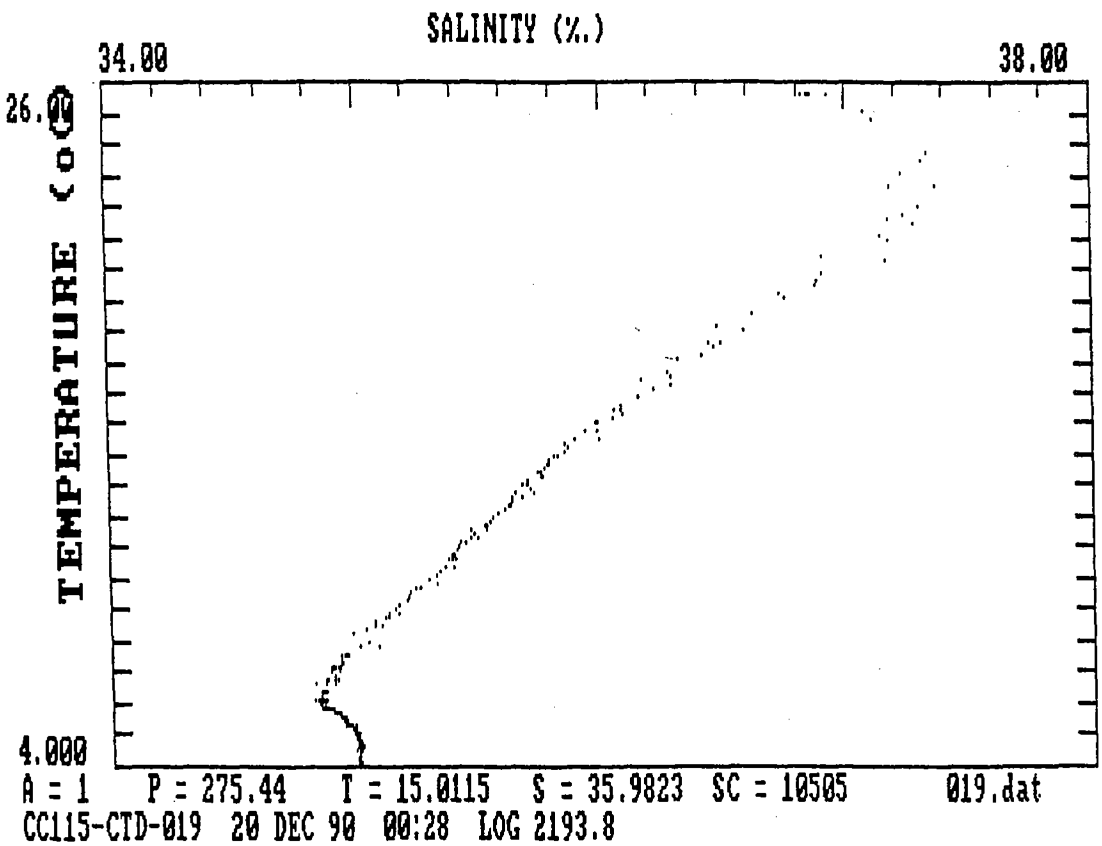


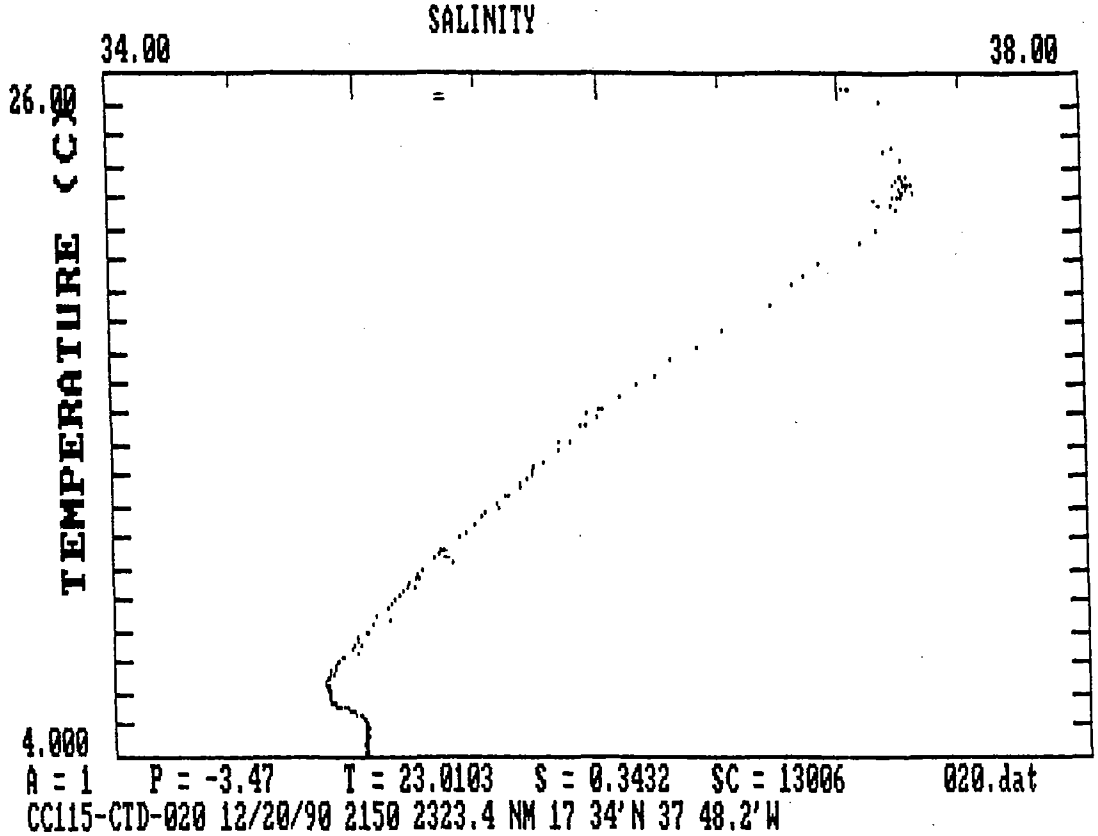
CC115-CTD-015 12/15/90 20 0.1'N X 25 05.7'W

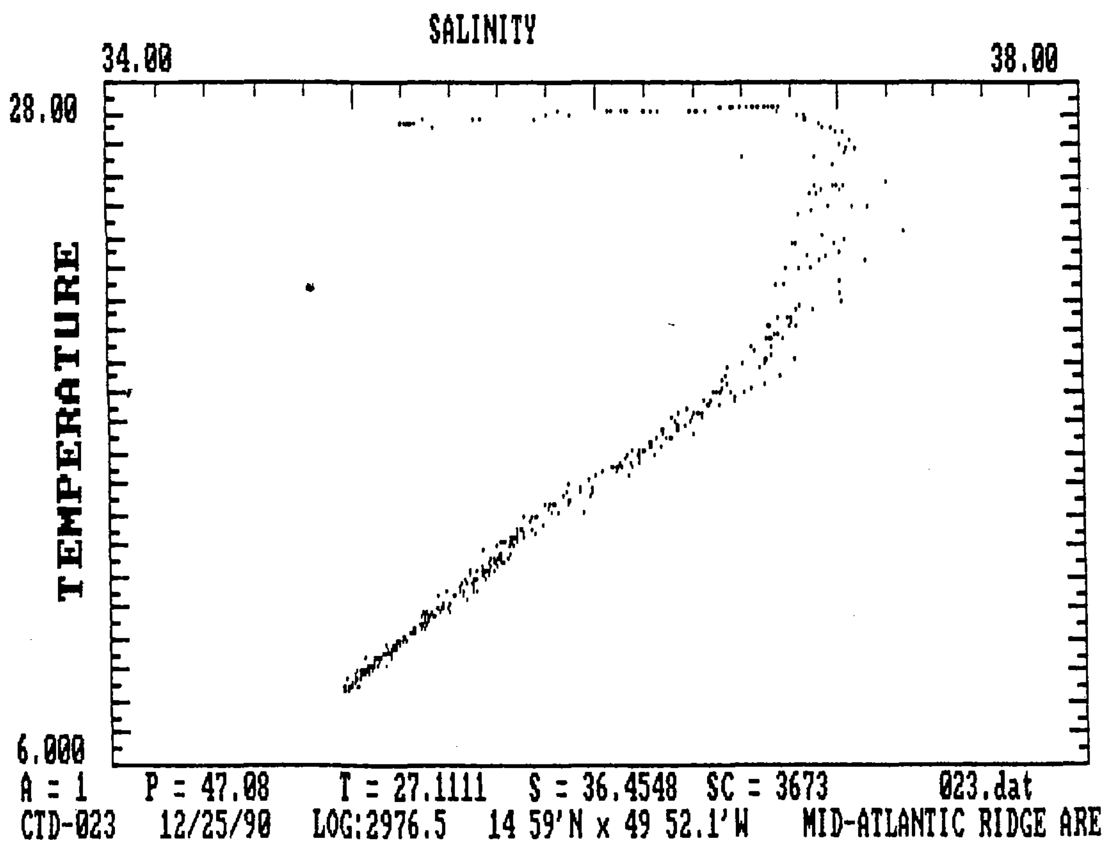

SALINITY (%.)
33.50
37.50
25.00
-2.000
TEMPERATURE (C)
A = 1 P = 148.19 T = 19.3435 S = 36.8223 SC = 12727 016.dat
CC115-CTD-016 12/16/90 18 56.0'N X 28 29.0'W


SALINITY (%.)
33.50
37.50
20.00
-2.000
TEMPERATURE (oC)
A = 1 P = 414.90 T = 12.4580 S = 35.5960 SC = 11313 017.dat
CC115-CTD-017 17 DEC 90 10:45 T-S STRUCTURE


SALINITY (‰)
34.50
36.00
10.00
TEMPERATURE
0.000
A = 1 P = 270.21 T = 13.5499 S = 35.7344 SC = 10505 018.dat
CC115-CTD-018 18 DEC 90 10:46 LOG 1999.2 T-S STRUCTURE


SALINITY (‰)
34.00
38.00
26.00
TEMPERATURE (oC)
4.000
A = 1 P = 275.44 T = 15.0115 S = 35.9823 SC = 10505 019.dat
CC115-CTD-019 20 DEC 90 00:28 LOG 2193.8


SALINITY
34.00
38.00
26.00
4.000
TEMPERATURE (C)
A = 1 P = -3.47 T = 23.0103 S = 0.3432 SC = 13006 020.dat
CC115-CTD-020 12/20/90 2150 2323.4 NM 17 34'N 37 48.2'W


SALINITY
34.00
38.00
28.00
6.000
TEMPERATURE
A = 1 P = 47.08 T = 27.1111 S = 36.4548 SC = 3673 023.dat
CTD-023 12/25/90 LOG:2976.5 14 59'N x 49 52.1'W MID-ATLANTIC RIDGE ARE

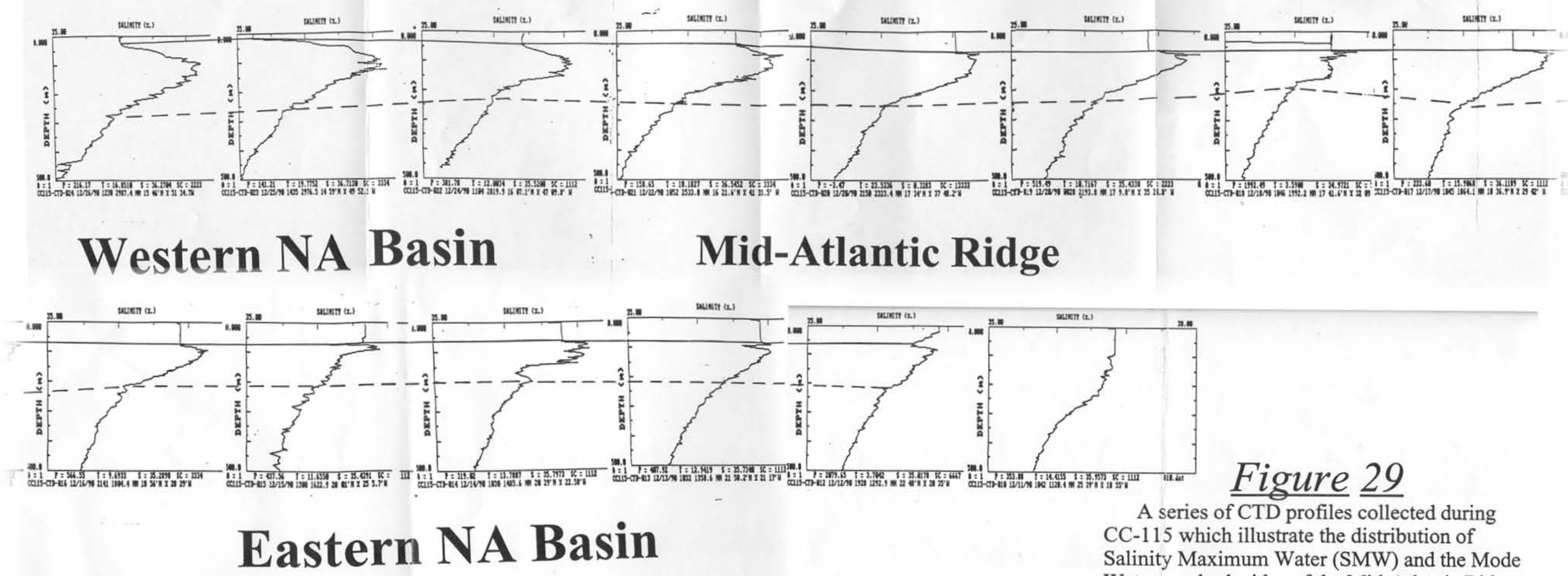


Figure 29

A series of CTD profiles collected during CC-115 which illustrate the distribution of Salinity Maximum Water (SMW) and the Mode Waters on both sides of the Mid-Atlantic Ridge. On the eastern side of the ridge the SMW is relatively shallow and weak and overlies the Madeira Mode Water. On the western side of the MAR the SMW is thicker and stronger and rests on the 18° Water. The solid line across the figure marks the base of the mixed layer or top of the SMW layer. The dashed line across the figure marks the base of the SMW or top of the mode water layers. Data complied by Busby, MacDonald, Cochrane and Kenna.